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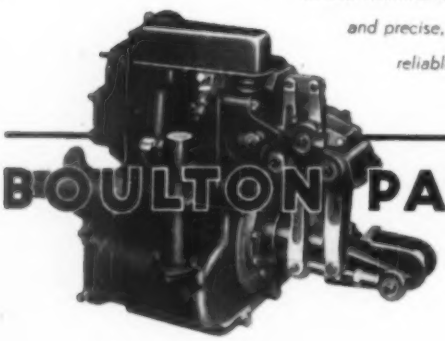

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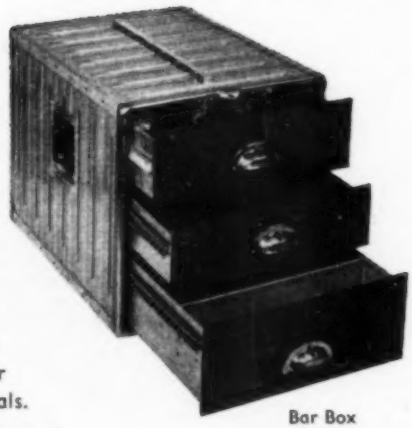

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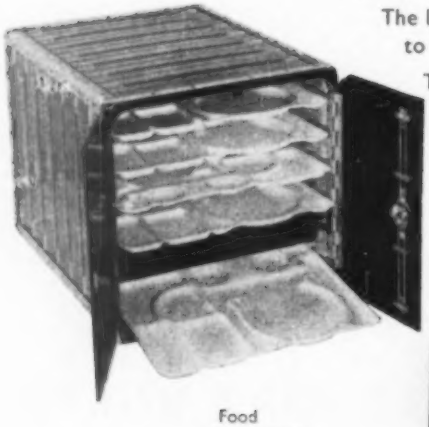

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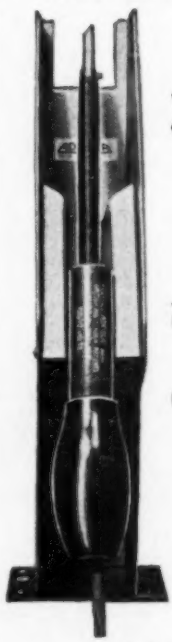

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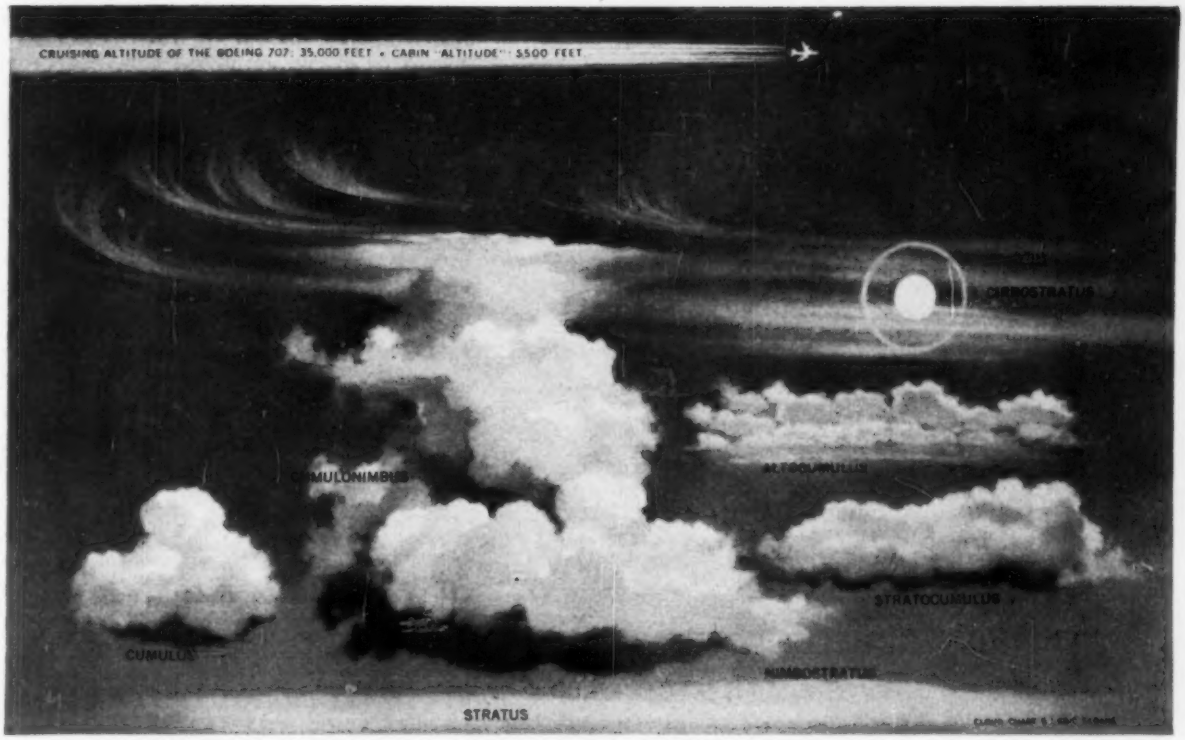

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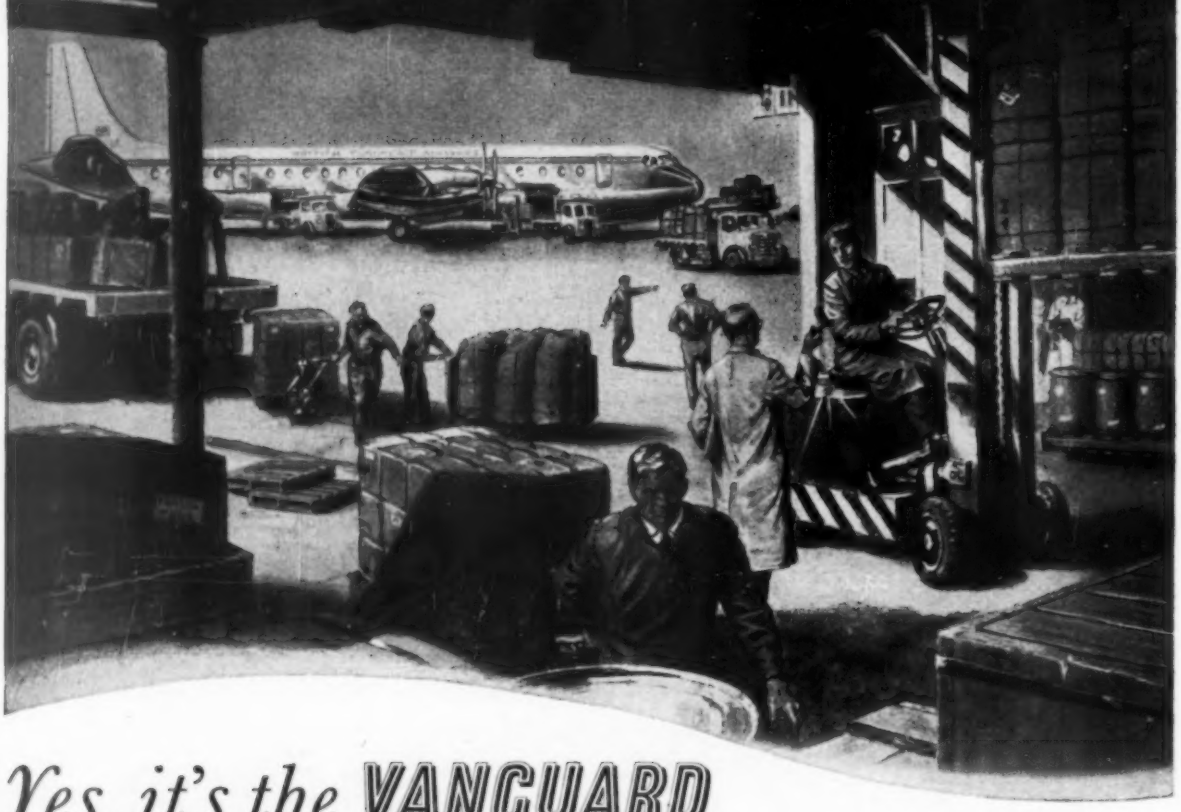
All this FREIGHT from a PASSENGER aircraft?



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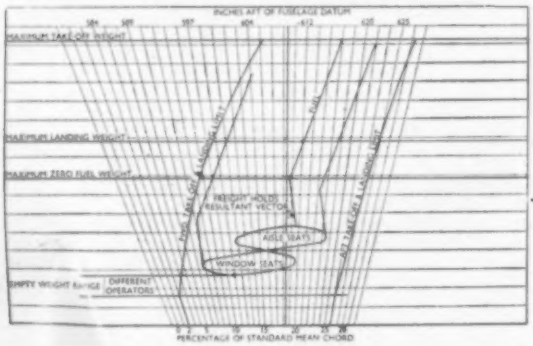

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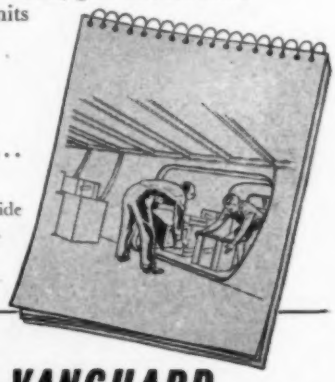

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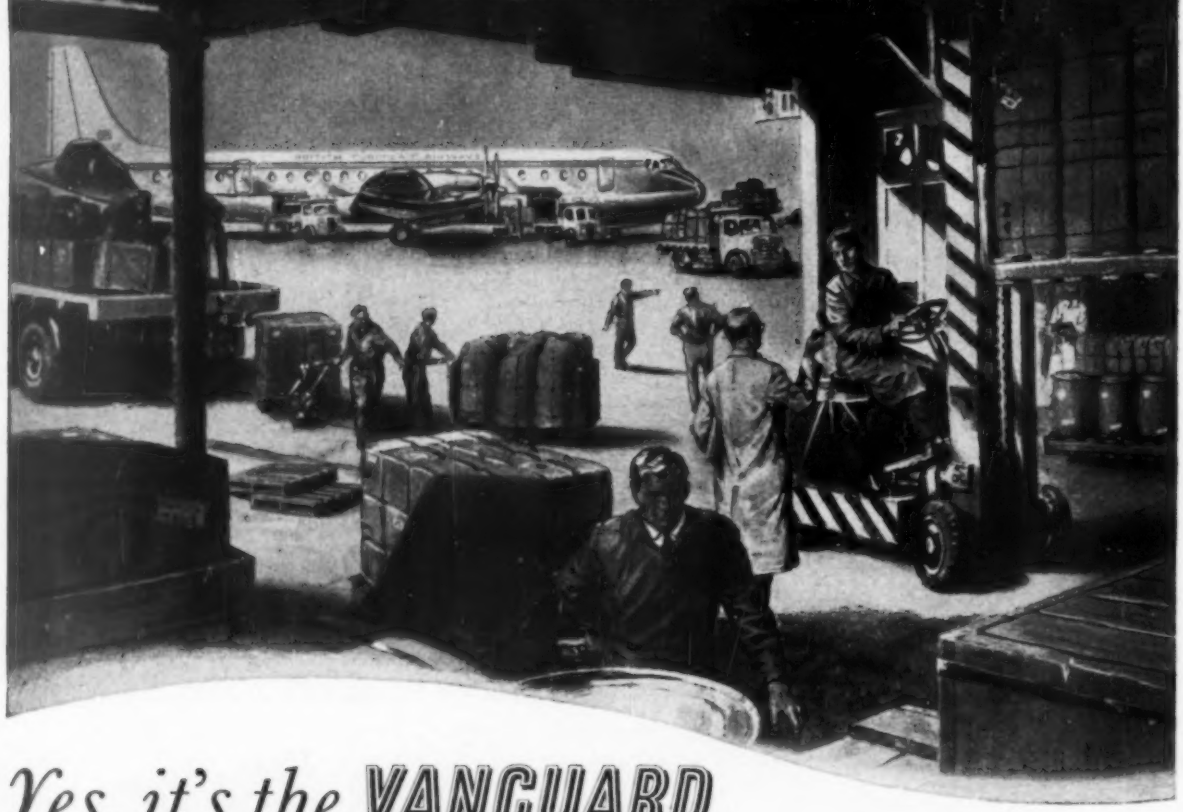

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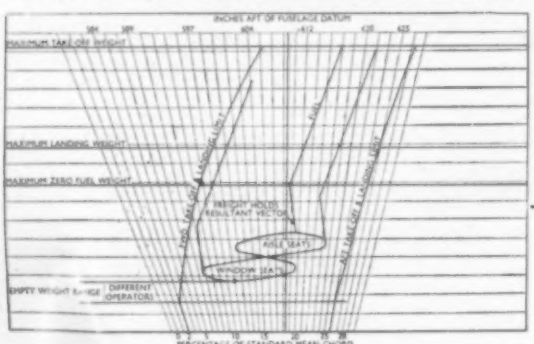

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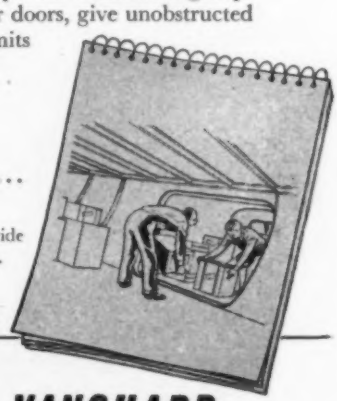

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SHARP CUSTOMER: A newly released photograph of the North American F-107A; capable of about Mach 2.1, the aircraft did not go into production, only six being built.

FROM ALL QUARTERS

Ballistic Progress

DURING the past few days all the major U.S. ballistic-missile programmes have made exceptional progress. Most spectacular single advance was the successful firing of the third XSM-65A Atlas from Patrick A.F.B. on December 17. As far as can be ascertained, this Atlas was fitted with the two boost motors only; photographs of the firing do not reveal a central flame from the sustainer motor. The firing was described as a "limited-range" test of some hundreds of miles and was completely successful. A re-entry nose cone was fitted.

The other ICBM, the SM-68 Titan, is now in preliminary production at Denver and the first prototype is scheduled to go on to the test-stand there in February. Thor, the U.S.A.F. IRBM, continues with successful firings and satisfactory results have been obtained with a prototype fitted with a completely representative guidance system. The latter will now be of the A.C. pure-inertial type, the Bell Telephone Laboratories "back-stop" system having been eliminated owing to the proven reliability of low-drift floating gyros.

JetStar for U.S.A.F.

EVALUATION of the Lockheed CL-329 JetStar prototype by the U.S. Air Force will begin early next month. Flight trials, which began at Edwards A.F.B. in September, have been most successful and the prototype has already logged more than 80 hours. Field performance has been better than predicted, level speed has exceeded 600 m.p.h. and rates of climb are unofficially reported to have reached 16,000 ft/min.

The JetStar is a company-financed venture to meet the U.S.A.F. "off the shelf" UCX utility transport competition. Although originally scheduled to have four General Electric J85 engines, the prototype is flying with two Wright TJ-37s each of approximately 4,500 lb thrust. These engines, which are imported Bristol Orpheus, will be available as an alternative powerplant for production JetStars.

Twiss Portrait for R.Ae.C.

PORTRAYED in the picture below is a pleasant occasion at the Royal Aero Club, when, last week, the Fairey Aviation Company presented to the Club a portrait of Peter Twiss, who raised the world's air speed record to 1,132 m.p.h. in the Fairey Delta 2 on March 10, 1956. The painting—from a photograph taken immediately after the flight—is by Mary Eastman, whose father painted the portrait of the late Sir Richard Fairey which hangs in the Club.

Making the presentation on behalf of Faireys, Mr. G. W. Hall (chairman) said that despite the fact that every effort had been made it was only recently that the speed had been exceeded by 75 m.p.h. "I congratulate the Americans," he added. "The fact that we do not now hold the record in no way diminishes Peter Twiss's achievement, for he raised the existing record by 310 m.p.h."

Paying a tribute to all those concerned with the Fairey record, Mr. Hall made particular mention of Rolls-Royce, Ltd. Their deputy chairman, Mr. J. D. Pearson, was among those who attended the presentation.

THE FACE OF SPEED: As recorded on this page, a portrait of Peter Twiss, who until recently held the world's air speed record, has been presented to the Royal Aero Club by the Fairey Aviation Company. The presentation was made by Mr. G. W. Hall (right) and the picture (seen here with the subject) was received on behalf of the club by Col. R. L. Preston (left), the secretary-general.

"Bedstead" Inquest Verdict

AFTER seeing a film of the last moments of the second Rolls-Royce "flying bedstead" test rig, in which W/C. H. G. F. Larsen lost his life on November 28, a coroner's jury at Hucknall on December 16 returned a verdict of accidental death. Mr. C. A. Mack, Nottingham District Coroner, told the resumed inquest that there had been a very searching inquiry into the possible cause of the disaster and "any question of mechanical fault" had been entirely ruled out.

Sopwith Apprentices United

ONE-TIME apprentices of the Sopwith Aviation Co.—World War 1 forerunner of the Hawker Siddeley Group—met for the third annual reunion dinner of their association at the United Service Club in London on December 11, with Mr. R. W. Sutton in the chair. It was a very pleasant, reminiscent occasion, and some early photographs and lantern slides lent by Sir Thomas Sopwith were of exceptional interest.

A. Cdre C. B. Wincott toasted the new president (succeeding the late Mr. Fred Sigrist), Sir Thomas Sopwith, who in his reply also proposed the association. To this toast A.V-M. L. T. Pankhurst responded. Sir Frank Spriggs replied to the toast of Hawker Aircraft, which had been proposed by Mr. J. H. Williams; his comments on the state of the industry and aircraft orders were of a confidential nature. The final toast on the list was that of "our guests," proposed by Mr. Frank Buckle, to which the editor of *Flight* responded.

The hon. secretary of the Sopwith Apprentices Association is Mr. V. W. Derrington, of 159 London Road, Kingston-on-Thames. He reported on activities, mentioning particularly a visit to the Shuttleworth Collection. During the latter part of the evening Mr. Thomas Sopwith, Jnr., who was among the guests, was unanimously elected an extra-ordinary member.

Among others who spoke during the evening were G/C. "Jimmy" Jeffs, Commandant of London Airport and S/L. "Joe" Taylor, representing the Avro 504 Club, which is closely associated with the Sopwith apprentices.

IN BRIEF

Elected president of the Institute of the Aeronautical Sciences for 1958, Mr. Edward C. Wells, vice-president engineering of the Boeing Airplane Company, succeeds Mr. Mundy I. Peale, president of Republic Aviation Corporation. Mr. Wells will take office at the I.A.S. Honors Night Dinner on January 28.

* * *

Sud Aviation announced recently that a contract had been concluded with Republic Aviation Corporation for the manufacture of Alouette 2 helicopters in the U.S. The value of this contract has not been revealed, but according to the French Air Minister it is for 60 machines.

* * *

Authorization is to be sought from Congress by the Defense Department for the installation, at a cost of $500m, of a new type of long-range radar—probably that developed by Columbia University and the U.S.A.F. Rome Air Development Center, using the "fine-structure analysis" technique—in the Distant Early Warning line across Alaska and Canada. Said to have a range of at least 2,500 miles, the new equipment is expected to give more than 15 minutes' warning of ICBMs.

INTERDICTOR TRAINING

A LABS Run in a Canberra B(I)8 of No. 88 Squadron

RECENTLY a member of "Flight's" editorial staff, while doing his R.A.F.V.R. annual training in 2nd T.A.F., flew on a routine training sortie with No. 88 Sqn. This was arranged with the willing co-operation of the squadron commander, W/C. D. T. Witt, D.S.O., D.F.C., D.F.M., and it is believed to be the first time a writer—as distinct from a photographer—has flown with a Canberra B.8 squadron. It is certainly the first occasion on which a journalist has participated in a LABS manœuvre. The article which follows contains our staff member's impressions.

HAVING played an important and varied part in both world wars and the Korean war, No. 88 Squadron (equipped with Blenheims and Bostons from 1940 to 1945 and with Sunderlands in Korea) gained a new distinction when it was re-formed in 2nd T.A.F. 18 months ago to operate B(I)8 night interdictor Canberras. Since then, at first under the command of W/C. J. A. Holmes and now led by W/C. D. T. Witt, it has achieved a high standard of proficiency not only in low-level interdiction but also in medium- and high-level bombing.

It should be emphasized at the outset of this account that the flight which it describes was not in any sense "laid on" as a demonstration trip. The crew were carrying out routine training, making the best possible use of every minute in the air to practise navigation and bombing plus LABS,* homing and let-down procedures.

Canberra B(I)8s have an offset fighter-type bubble canopy through which the pilot can get a good all-round view, necessary indeed when travelling at 350 kt only 250ft (or less) above ground level. The navigator normally occupies a seat at the plotting-table (just forward of, and below, the pilot's position) with limited outward visibility through a small window on the port side; or he lies prone in the nose, which is completely transparent and affords an excellent area of visibility. There is also a rumble seat beside the pilot, who on this occasion was S/L. Max Charlesworth; but for take-off the navigator, F/L. Ken Utton, gave me his seat at the table (facing aft), later exchanging places when low-level exercises had been completed.

There was a little trouble with generator warning lights after the Avons had started, but it proved only temporary; in the meantime I was able to look round and see how little room there is to spare in the front compartment of the black-camouflaged B(I)8s (especially when a passenger is carried). Chiefly it is the lack of head-room which gives this impression. After the slight delay we taxied fast to the end of the Wildenrath runway in use and awaited control's "Clear to go."

We were airborne at 1042, the Avons with their combined 15,000 lb thrust sucking us smoothly off the runway, and settled down to an initial cruise of 335 kt at 2,000ft before reaching the low-flying area. Eight minutes after take-off we crossed the Rhine and two minutes later Utton gave his pilot a course of 320 deg to steer. Charlesworth had meanwhile been listening-in to the bombing range R/T, and when he learned there were two aircraft already there said to Utton: "Take me wherever you like."

We then altered course to 330 deg, flew over Wesel and turned north-eastwards on to 050 deg, going down to 250ft at an I.A.S. of 350 kt. Charlesworth remarked that there was always a risk of hitting birds on this low-flying practice, some of them big ones. (At times the squadron is committed to studying bird migratory habits in order to avoid the unusually large flocks which pass through its low-flying areas.)

We were now in one of these areas, of which there are several—linked by corridors—marked on the squadron maps of northern Germany. The ground is fairly flat and predominantly agricultural terrain, though sprinkled with occasional small towns (which we scrupulously avoided). Utton gave his pilot some rapid changes of course—020, 040 then 060 deg—and in the Canberra's pressurized interior (No. 88 Sqn. proverbially works either "on the deck" or at 40,000ft) conditions were rather bumpy and stuffy. B(I)8s, especially in hot summer weather when operating at low altitude, cannot make the navigator's life a very happy one.

After passing near Hessle, a well-bombed airfield still pock-marked with the Allied craters of twelve or more years ago, we turned on to 015 deg and climbed up to do a practice G.C.A. at Ahlhorn. This was completed successfully almost to touch-down, then broken off with an overshoot.

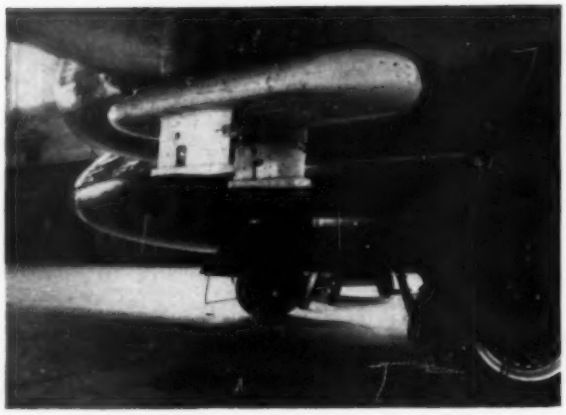
From Ahlhorn we made for the Nordhorn bombing range, a matter of 12 minutes' flying, first at about 5,000ft then going down again under some low cloud. When nearing the range, we climbed to something over 25,000ft—I had by then moved forward into the prone position and did not have an altimeter in view—to do some simulated bombing runs. (Unfortunately it proved impossible to do any actual bombing, for the range had by now gone unserviceable: a truck had become stuck in the mud and efforts were still being made to pull it out.)

Far below us there was now thick immobile stratus, looking like frosted snow. (I noticed, too, after examining the unrestricted view downwards, that it was just possible to see the pylon bombs when looking backwards from the farthest point in the nose.) With pressurization, the aircraft's equivalent altitude was then about 12,500ft; and there was a noticeable absence of vibration, with comparatively little engine noise. But a marked juddering occurred when the bomb doors were opened and after the first run Charlesworth was not satisfied about them being closed properly, since he was not getting the correct speed for the correct revs.

As after two dummy runs there was not much point in staying any longer over the unserviceable range we turned back to do a practice QGH on Wildenrath, starting it from 60 miles away on a course of 215 deg, which brought us over base with only a 2 deg alteration when just under 20 miles out. At that point, Charles-

**LABS = Low Altitude Bombing System, more commonly known as toss bombing, loft bombing or over-the-shoulder bombing.*

Graceful but pugnacious (its under-fuselage pack conceals four 20 mm cannon): an English Electric Canberra B(I)8 of No. 88 Sqn. over Germany. "Flight" photograph



Above left, S/L. M. Charlesworth (left) and F/L. K. Utton, pilot and navigator on the flight described; above right, a B(I)8 with pylon bombs and wing-tip tanks, showing the offset cockpit canopy; and lower right, installation by Saunders-Roe, Ltd., for two 20 lb or 25 lb practice bombs beneath each pylon.

INTERDICTOR TRAINING . . .

worth throttled back his port engine to make the actual QGH descent an asymmetric one and started it from 20,000ft at 250 kt with air brakes out.

When this practice had been completed we climbed again—the Canberra getting back to 20,000ft in what seemed to be (without instruments to observe the rate of climb) an astonishingly short time—to do a controlled descent, by spiral turns, after a simulated double flame-out. What impressed one about this exercise was its final accuracy and the B(I)8's civilized angle of glide at 170 kt.

At the start, we were 15 miles away from the airfield, and subsequent dialogue between pilot and controller went like this: "Ten miles . . . 19,000ft now . . . Five miles to go . . . Seventeen-and-a-half thou . . . 15,000 . . . Continue turning left . . . Thirteen-and-a-half thou . . . You're still in the cone." (Our rate of descent was now 1,400ft/min.) . . . "Levelling on 180 deg . . . You are back overhead again . . . Recommence spiral descent, left, left . . . Two-eighty, eight-and-a-half thou . . . 340, angels seven."

Just below us now, at about 6,000ft, there was eight-eighths cloud; through and beneath it, our descent continued to the same pattern and was only broken off when we were in a good position for landing—an excellent example of accurate co-operation between pilot and controller. Following this, we climbed again above cloud for the last two practices of the morning.

One of these was the prescribed manœuvre—a half loop with a roll off the top—for the LABS bombing procedure. This was accomplished with remarkable smoothness from level flight at approximately 430 kt. From the prone position, one watched the nose rise steadily above the horizon, then point at the sky; but the transition from inverted flight to the rolled-out position was so quickly achieved as to be barely perceptible. The navigator, however, in his seat at the table—an unaccustomed position for him during LABS bombing—felt the full force of the g exerted during the climb to an inverted position.

This practice, of course, was carried out at an artificial altitude; in operations the speed would be lower and the attack made at a height designed to be low enough to escape radar detection and guided missiles. In fact, the manœuvre forms the sequel to the type of low-level cross-country we had been practising.

We finished the morning's session with a single-engined G.C.A., which positioned us admirably—again through good instruction and accurate flying—for a final visual approach to the runway in use, on to which the aircraft wheels rumbled at approximately 1310. We had thus been airborne for almost 2½ hours, every minute of which had been used intensively for training. The amount of work which had been accomplished in this routine sortie indicates the ardour with which the crews of No. 88 Sqn., whose keenness and morale are of a noticeably high order, maintain and improve their operational efficiency as a 2nd T.A.F. bombing and ground attack formation in the spearhead of NATO defence of Western Europe.

H.W.

U.S. ARMY ADOPTS FRENCH MISSILE

AFTER exhaustive tests over several years the Nord SS-10 anti-tank rocket is being ordered in quantity for the U.S. Seventh Army in Germany. An initial batch, said to number well over a thousand, is being bought for field service trials. Already in use with the French Army, the SS-10 is understood to have been ordered by Sweden, Switzerland and Norway.

A cruciform tailless rocket, spin-stabilized and with vibrating-spoiler trailing-edge flying controls, the missile is remotely controlled through twin wires by an operator using a binocular sight and joystick control. It is normally mounted in batteries of six and can be fired from the ground, vehicles, ships or low-speed aircraft, including helicopters. A live round weighs 33 lb, is 33.85in long with a span of 29.52in, and has a range of about a mile within a sixty degree "fan" from the launching site. Speed is subsonic, and the standard missile can penetrate 20in armour.

The SS-10 system includes a transport/launcher crate (or, alternatively, zero-length launching rails on aircraft), a guidance/control unit, and also a synthetic basic trainer and a simulator.

Who Pays for the Civil Jets?

Equipment Finance: The Airlines' Dilemma

IN the spring of 1955 an order for 20 de Havilland Comet 4s was placed by B.O.A.C. That summer Boeing and Douglas announced their intention of marketing turbojet airliners, but it was not until late in the autumn that the first aircraft were ordered. With the exception of Pan American, all the first purchasers were U.S. domestic airlines. But in November, Douglas announced the sale of eight DC-8s to K.L.M. By the year-end Air France, S.A.S., Sabena and Japan Airlines had followed suit. The race was now on.

Orders flowed in steadily throughout 1956, and at this stage a controversy developed as to whether the appearance of these aircraft in 1959 and 1960 would result in excess capacity. During 1957 the flow of orders slowed down to a trickle. Many prospective customers were having second thoughts, not only on the dangers of creating over-capacity, but also on the fundamental economics of turbojet operation. (It is significant that 1957 saw a swing of procurement in favour of turboprop aircraft.) As delivery dates—and payment dates—draw nearer, those airlines who had already ordered turbojets have begun to ask themselves an uncomfortable question—"Where will the money come from?"

The amounts involved are considerable. Douglas and Boeing have each sold almost 150 turbojets. Additional sales are 48 CV-880s, 25 Comet 4s, 18 Caravelles and 35 VC-10s. The total value of these orders is about £750 million. To obtain such a vast amount of money in time to honour existing obligations is a problem which has yet to be solved.

The ploughed-back earnings of the U.S. carriers as a whole are quite inadequate to meet such a demand. A high proportion of the non-U.S. carriers are still requiring subsidy to cover their costs, let alone to build up reserves. It is possible to remedy this shortage of undistributed profit by increasing fares. But this course can be self-defeating if higher fares lead to a slowing down in traffic growth. Even if fares could be put at the limit set by this factor, it would still be necessary to look outside for other sources of finance.

Shy Shareholders

Those airlines which are public companies can appeal to their shareholders. But airline shares are not popular with private investors. Past dividend rates have been too low. Shareholders have also been scared by the controversy over the economics of turbojets. Airlines have placed so much emphasis on their poor financial condition—in their attempts to obtain approval for fare increases—that there is little possibility of raising sufficient capital from this source.

Airlines have been more successful in approaching financial institutions. American carriers have been able to draw upon the resources of their national banks and insurance companies. Other airlines have frequently made use of the facilities offered by the Export-Import Bank. But again, this method has severe limitations. Interest payments could be crippling (American Airlines has arranged a loan of $135 million to cover the purchase of 30 Boeing 707s. Annual interest on this sum will exceed $6 million—more than the cost of one 707.) The institutions themselves appreciate this problem and are reluctant to see too high a proportion of their clients' funds being in the form of loan capital.

Still hungry for money, the airlines have one other possible source to tap—their national governments. There are three ways in which money can be taken from the pocket of the taxpayer and deposited in the tills of the airlines. The most obvious form is direct subsidy. An impression of the wide extent of airline subsidy can be obtained from I.C.A.O.'s recently published digest, *Financial Data 1955*. The following figures show subsidies for only a few of the many subsidized carriers in that year—Air France, $9.7m; Aerolineas Argentinas, $8m; Panair do Brasil, $4.6m; Aerovias Brasil, $1.2m; Pan American, $1.0m.

Alternatively, the airlines might benefit from indirect subsidy such as uneconomic landing fees or high mail rates. Here the outlook is less bright. Many airport authorities are digging their heels in. Swissair is having difficulty in persuading the appropriate local bodies of the need to extend runways to allow turbojet operation. United Kingdom airport charges have recently been increased. As regards mail rates, the general trend is downward. At a conference held in Ottawa last autumn the airlines pressed for higher mail rates. Although the resolutions of this conference have not yet been published it is probable that the postal authorities have had their way, and have managed to reduce the mail rates paid to airlines.

An even less direct form of government assistance is taxation relief. This does not usually take the form of a concession in normal tax rates, but is achieved by applying a less stringent definition of taxable expenditure. The principal item of expenditure involved is depreciation.

Permission to allocate higher depreciation charges has the immediate effect of reducing taxation payment and of increasing profit by a like amount. In theory, the reduction in taxation paid in earlier years when depreciation rates are very high is balanced by the extra taxation paid in later years when high profits are being earned on fully-depreciated aircraft. But in practice the aircraft in question is normally transferred to another owner before the second stage takes effect. As the aircraft has been written down in the first stage to a value well below its probable selling price it is likely that high depreciation rates will mean substantial capital gains. High depreciation rates are seen to allow both increased net profit and higher capital gains.

Accelerated Depreciation

Although American carriers have not enjoyed the lavish subsidies so frequently available to airlines abroad, this disadvantage has been largely offset by permission to depreciate their aircraft at a faster rate. Under the mobilization policy introduced early in the Korean war, U.S. airlines were frequently allowed to depreciate over very short periods in an attempt to facilitate purchase of strategically superior aircraft. The impetus behind this concession came from the defence authorities. In recent years this impetus has waned. But the practice which it engendered—the ability to purchase the latest aircraft without needing to depend on assistance from outside investors—has continued. Unfortunately, the jets appeared just about the time that defence needs were relaxed and tax concessions accordingly reduced. The Civil Aeronautics Board were pressed to approve higher depreciation charges. But after almost two years' deliberation they have just announced that from next January aircraft must be depreciated evenly over a minimum of seven years down to a minimum residual value of 15 per cent. Although these rates appear low to American airlines, to most other carriers they are comparatively generous. B.O.A.C. and B.E.A. have until this year been depreciating over a period of ten years, and only recently have stepped their rates up so as to depreciate their aircraft to a residual value of 25 per cent in seven years.

Regardless of which course each airline follows in its search for capital, the outcome will depend on one factor: whether the government concerned approves its purchase of jet aircraft. Where governments are anxious to see their national carriers operating the latest equipment, then ways and means will be found to arrange the necessary finance. (The Indian Government, for instance, has guaranteed the principal and interest on loans amounting to $16.8m negotiated by Air-India International with the International Bank and five American commercial banks.) For this reason it is unlikely that the fare increases proposed by I.A.T.A. will be opposed by governments other than that of the United States.

A Changed Attitude?

In strong contrast, the C.A.B. have resolutely refused to allow fare increases either on domestic routes or on foreign routes to and from the U.S. Their attitude is based on sound economic reasoning: if the characteristics of these new aircraft were as attractive as was claimed by manufacturers and customers, then sufficient capital for their purchase should be forthcoming on the prospects of operating these aircraft profitably; if this is not the case, then the aircraft should not have been bought; if airlines have already chosen to swim out of their depth, there is no reason why today's air travellers should come to their rescue.

It is likely that the C.A.B.'s present policy will be modified. A situation could develop where U.S. airlines, having originally precipitated the jet procurement programme, are forced to cancel their orders while state-aided airlines abroad continue to order even more jet aircraft. It is the consequences of such a situation, rather than the arguments—and threats—of the air transport and manufacturing industries, that is likely to cause the C.A.B. an "agonizing re-appraisal." Another factor recently brought to the fore is the quickening pace of aeronautical development in the U.S.S.R. The imminent possibility of Russia becoming an exporter of airliners such as the Tu-114, and an operator of highly competitive international air services, is now putting an increasingly greater premium on considerations of prestige and strategy.

It seems that if the public are to have jet airliners tomorrow they must pay more today—whether they like it or not. J.C.S.

ROBOT SPY: Described as a "surveillance drone," this pilotless aircraft for the United States Army uses "advanced surveillance sensory devices" and is being produced for the Army's Signal Corps by Republic Aviation. Designated SD-3, the drone can be operated in all weathers and is zero-launched.

HERE AND THERE

Voodoo Pilot Decorated

PILOT of the McDonnell F-101A Voodoo which reached an average speed of 1,207.6 m.p.h. in two measured runs over California, Maj. Adrian Drew was on December 13 decorated with the D.F.C. by Maj.-Gen. McCarthy.

U.S.A.F. Airfields Transferred

FOUR U.S.A.F. airfields in Bavaria—Fürstenfeldbruck, Landsberg, Kaufbeuren and Erding—were handed over on December 14 to the West German Air Force.

Swiss Hunter Debate

A SPECIAL session of the Swiss Parliament is being held from January 27 to January 31 to discuss the government's proposal to buy 100 Hawker Hunters. This is because an order must be placed by next January or February if Switzerland is to be assured of delivery by the end of 1959. The next regular session of Parliament does not begin until late March.

Snark Launching Base

CONSTRUCTION of a base in Maine for launching Snark surface-to-surface missiles is to begin in January. This was announced by the U.S.A.F. in Washington on December 13. [In *Flight*'s December 6 special issue on Guided Missiles, the description of Snark stated that "last month contractors were assigned to prepare facilities for the first operational sites on the Atlantic seaboard."]

Bangalore Orpheus Progress

PLANS for manufacturing the Bristol Orpheus under licence at Bangalore are reported to be progressing satisfactorily and "an advanced version" is to be produced in numbers before 1960 to power Folland Gnats being built by Hindustan Aircraft, Ltd. It was announced in August last year that Gnat airframes would be manufactured under licence by the Hindustan Aircraft company and that a new factory would be set up at Bangalore to build the engines.

Indian Weather Study

A CONFERENCE was recently held in New Delhi to study meteorological requirements following the introduction of jet aircraft on Indian domestic services. It was attended by representatives of the Civil Aviation Department, the I.A.F., the Meteorological Department and Indian and foreign airlines.

Soviet Space Epic

A FILM titled *I Am a Space Pilot* is being made by the Moscow Science Fiction Film Studio. It tells the story of a young space pilot who takes his scientist father to a Sun satellite to study cosmic rays. The film, we are assured in a news release, "combines audacious fantasy with strict scientific fact."

Recognition Competition

NEXT year's All-England Recognition Competition is to be held by the Aircraft Recognition Society on January 18 at the Royal Institution, Albemarle Street, London, W.1. For the test, 35 distant views of aircraft are projected for very brief periods on a screen. The competition is open to teams of three from any recognized civilian club or society or from units of H.M. Forces, the A.T.C., W.J.A.C., R.O.C. and NATO.

Historic Vimy Drawings

ENOUGH basic information has been found, following a search through a pile of discarded working drawings at the Weybridge premises of Vickers-Armstrongs (Aircraft), Ltd., to enable the historic Vickers Vimy recently damaged by fire in Australia to be rebuilt. The aircraft, flown by Capt. Ross Smith and Lt. Keith Smith from Britain to Australia in 1919, was damaged when being transported by road from Canberra to Adelaide. Prints of the drawings will be sent to Australia *via* Royal Australian Air Force headquarters in London.

Polish Missiles

AN article by Brig-Gen. Czubryt-Borkowski in the Polish Army newspaper *Zolnierz Wolnosei* says that Poland is now producing tactical ballistic missiles and is "in no way behind" the U.S.A. and Britain in rocket equipment. The general added that it would be a long time before the other NATO countries produced their own atomic weapons, because they had fallen behind in scientific research and their economies could not stand the expense.

Faster than the Record

A SOVIET test pilot, Colonel Nikolai Korovushkin, is reported to have flown a new fighter prototype at over 2,000 km/hr (1,242 m.p.h.). Moscow Radio has reported the aircraft has "sharply swept-back wings, an arrow-shaped tail assembly, rocket-like fuselage and protruding jet pipes." The first flight is said to have been so successful that on the same day Korovushkin took it up to "normal operational altitude," where "he was able to perform all tactical manœuvres in the horizontal and vertical planes."

Mr. P. C. Garratt, A.F.C., whose appointment as an ordinary director of de Havilland Holdings, Ltd., was recently announced ("Flight," December 20). He is managing director of de Havilland Aircraft of Canada, Ltd.

Who Counted Them?

ACCORDING to a news release from Australia House, a Christmas pudding sent to the R.A.F. Benevolent Fund's orphanage at Blackheath contained 15,180 Australian currants, 3,920 Australian sultanas and 906 Australian raisins.

GYROCOPTER is the maker's name for the family of light helicopters produced by the Bensen Aircraft Corporation. The latest—1958—model, the B-8M, is shown here, flown by Igor Bensen. It can lift 300 lb on the power of a 72 h.p. McCulloch flat-four two-stroke.

ON BALANCE

By M. DUFFY

A RETROSPECTIVE study of the aircraft industry of this country, and of the industries closely associated with it, shows how great has been the rate of expansion since various well-known companies were first registered. To begin by going some way back into the industry's history, it may be remarked that 1935 was an especially significant date in aviation-industry finance, as it saw the registrations of both the Bristol Aeroplane Company and of the present Hawker Siddeley Group.

The Bristol Aeroplane Company was first incorporated in 1910. In 1921 it acquired the business at Filton, Bristol, of the British and Colonial Aeroplane Company. In the same year it started the design and the production of aero engines. At that time it was stated that the total number of workpeople and staff employed exceeded 4,200. Buildings, comprising the company's works, offices, etc., covered an area of upwards of thirteen acres, exclusive of the Filton Aerodrome.

Trading profits for some years past have been steadily on the up-grade, as the figure for 1956 was returned at the new high level of a shade over £4,000,000. This compared with £3,392,000 for 1955 and £2,918,000 for 1954. The chairman's speech for 1956 stated that it was evident that the number of new aircraft projects undertaken in this country would be fewer. The competition to secure them was consequently envisaged as being keener; further, the proportion of business related to civil and military transport aircraft, as distinct from combat types, would be greater than in the past. They considered themselves, however, well placed to secure a good share of such work and carry it out effectively.

Hawker Siddeley Group (formerly Hawker Siddeley Aircraft) was formed to acquire the whole of the issued Ordinary capital of the Armstrong Siddeley Development Corporation and half of the issued Ordinary capital of Hawker Aircraft. This concern's fortunes of recent years have followed the same lines as those of the Bristol company, as group profit for the year ended July 1957 was returned at the new high level of £20,500,000, against about £17,000,000 for 1956, £15,700,000 for 1955, £11,400,000 for 1954 and £7,900,000 for 1953. City comment on the figure for 1957 was on the lines that none of the acquisitions made this year, notably the Brush group and Dominion Steel, would have affected, except to a very minor extent, the latest figures issued.

It was also suggested that as only about £1,000,000 of the latest increase is traceable to the A. V. Roe Canada subsidiary it followed that the bulk derived from the group's operations in this country, which was considered an excellent result. The picture was, perhaps, slightly marred by the rise in depreciation from £3,930,000 to £6,340,000 and by the new item of special development expenditure of £2,130,000. A final point made was that the firm had a big programme of development and research so that the special development expenditure should be regarded more as a capital item.

Rolls-Royce is noteworthy in that foreign holders have no voting rights, and also because its trading profit trend for some years past has been on parallel lines, as this figure for 1956 was returned at the new high level of £7,598,000. The corresponding figure for 1955 was £5,900,000 and those for 1954 and 1953 £6,631,000 and £4,000,000-odd respectively. Shareholders were informed that during 1956 the factory output, as well as orders taken, had reached record figures, and that group sales totalled £80,000,000. This increased turnover, however, was not matched by a corresponding increase in trading profits. The company were having to expend substantial sums on the development of future products, particularly aero engines. In addition, they were having to make substantial payments to the Ministry of Supply in respect of development expenditure incurred in past years. They were confident, however, that in due course their policy would be reflected in still further increases in their business. A final point was that their backlog of firm orders stood at about £100,000,000.

The Financial Progress of the Aircraft Industry

de Havilland Holdings, as will be seen from the table, is the last of the four aircraft companies in it capitalized at over £10,000,000. Its trading profits trend over the past few years has, however, been on slightly different lines; although the figure for 1956 was returned at the new high level of £5,500,000, against £3,900,000 for 1955, the corresponding total for 1954 was shown as only £137,200 and that for 1953 as £3,920,000.

The exceptionally low figure of £137,200 for 1954 was reached after providing the appreciable total of £4,732,000 for exceptional losses arising in connection with Comet production. The striking recovery for the years 1955 and 1956 was noticed by a leading City commentator under the headline "de Havilland Resurgent."

Points stressed were, first, that the results for 1956 showed how completely the Comet after-effects had been shaken off, and second, how they reflected the growth of the Canadian interests, as the separate figures published would appear to show that de Havilland of Canada accounted for something over 30 per cent of the net profits, against the region of 10 per cent for the previous year. It was also indicated that the success of this interest was due at least in part to that subsidiary's specialist production of the Beaver and Otter. It was also emphasized that the beginning of a decline in sales of Ghost and Goblin gas turbine engines would be offset by the new range of jet engines, the most important of these being the Gyron, further that the company was pursuing its development in spite of Government support having been withdrawn.

Westland Aircraft, which had its origins as Petters, hold licences to manufacture certain types of Sikorsky helicopters. The year 1957 was an important one in the company's history as it saw trading profits at a new high level, i.e., £1,307,000, compared with £1,152,000 for the year ended June 30. The chairman said that following a further considerable increase in production, consolidated trading profit had risen compared with the previous year. The sale of Westland helicopters and spares to customers other than the Ministry of Supply had increased by about one-third as compared with previous years. Normalair, Ltd., and Westland Engineers, Ltd., had contributed to the year's successful results. Profit had again been ascertained after writing-off private-venture expenditure, most important of which during the year had been in connection with the development of the Widgeon and Westminster helicopters. Development, added the chairman, must continue to absorb a large proportion of the company's earnings, and in view of the uncertainties and hazards inherent in the aircraft industry, and the special national difficulties of the present time, it should be emphasized that no assurance could be given that the rate of dividend could necessarily be maintained in the future.

Consolidated trading profits of Fairey Aviation for the year ended March 31, 1957, have also shown a new high level, i.e., £2,548,000 against £2,458,000. The company's chairman said that they had had another successful year, as shown by the consolidated Group profit, but added that there had been some quite material variations in the sources of this profit. There had been a considerable increase in contributions made by overseas subsidiaries and by home activities other than those concerned with aircraft. This had offset the reduction in the sale of their products to the British Government, due to the reduced programme of Gannet aircraft and other work for the Ministry of Supply. The Board's policy of broadening its activities was continuing to have its effect and, in consequence, total profit had been maintained. Stock and work for 1957 was shown in the accompanying consolidated balance sheets as the appreciable total of £5,522,000, against £4,643,000. As will be seen from the table, this former figure is more than double the company's authorized capital.

D. Napier and Son's trading profits figure for 1956, at £679,200, was a slight reaction from the 1955 total of £759,300, this latter also being a new high level and comparing with £587,800 for 1954 and £474,700 for 1953. The 1956 figure for stock and work of £5,872,000 is more than double the authorized share capital total, and compares with a trifle over £6,000,000 for 1955. The 1956 total for stock and work, however, was quali-

ON BALANCE . . .

fied by the advice that it had been reached after £1,212,600 payments received on account.

This company's Ordinary capital is all held by the English Electric Company, the control dating from 1942. Two classes of Preference shares, however, are dealt in on the Stock Exchange, but their voting rights are restricted.

Blackburn and General Aircraft is in about the same capitalization group as D. Napier and Son, and it lately issued its annual report for the financial year ending March 1957. Trading profits were shown as a new high level, i.e., £1,175,000. This compared with £897,400 for 1956, £607,100 for 1955 and £529,200 for 1954. The latest results were noticed by a well-known City commentator on the lines that it was "an aircraft company with a difference."

AIRCRAFT AND ENGINE MANUFACTURERS

Name	Regd. as Public Co.	Authorized Share Capital	
		Then	Now
Alvis	1928	£200,000	£1,250,000
Blackburn	1936	£630,000	£2,000,000
Boulton Paul	1934	£300,000	£500,000
Bristol	1935	£1,200,000	£10,000,000
English Electric	1918	£5,000,000	£25,000,000
Fairey	1929	£500,000	£2,500,000
Folland	1936	£500,000	£1,000,000
de Havilland	1928	£400,000	£12,000,000
Hawker Siddeley	1935	£2,000,000	£40,000,000
Handley Page	1919	£500,000	£1,319,000
D. Napier and Son	1913	£650,000	£2,150,000
Rolls-Royce	1906	£60,000	£20,000,000
Vickers	1867	£155,000	£60,000,000
Westland	1935	£250,000	£4,000,000

The chairman's advice that the recent defence changes might increase the demand for their aircraft, rather than lessen it, was quoted in support of this description. The White Paper was also mentioned with its advice of the creation of a central aircraft reserve to be based in this country. This was interpreted as being scarcely effective unless aircraft were ordered to move troops, and especially their equipment. The chairman was further quoted with his expression of the opinion that as R.A.F. Transport Command, for financial reasons, would be too small to meet all emergencies the Government ought to encourage commercial operators to use aircraft suitable for military purposes. The Beverley was envisaged as such a type in view of its ability to operate from secondary airfields and to carry worthwhile payloads for long distances.

In the year that it became a public company, i.e., 1919, Handley Page, Ltd., was assigned by Mr. (now Sir Frederick) Handley Page all existing patents, designs and inventions involved in the Handley Page aeroplane, as well as any improvements or further inventions relating to aircraft made by him during the seven years ended December 31, 1925. This was done in consideration of the allotment to him of 140,000 fully paid Ordinary shares.

This company lately returned trading profits for 1956 at the new high level of £929,900 odd. It compared with £881,700 for 1955, £863,500 for 1954 and £830,400 for 1953. The chairman's statement for 1956 included the information that the development and the quantity production of the Victor strategic bomber for the R.A.F. had been their major activity, and further that the Herald branchliner was in production. Another point was that they were investigating the design of a supersonic civil transport in association with several other British aircraft constructors.

Stock and work here—i.e., £4,500,000 odd for 1956, against £3,250,000 for 1955—is about three-and-a-half times the authorized share capital. This increase was specifically noticed in the chairman's speech for 1956 with the advice that it had not yet reached its peak. Another point made was that during 1956 they had had recourse to their bankers for considerable overdraft facilities, and the position was envisaged as continuing during 1957.

Folland Aircraft, originally known as British Marine Aircraft, reported a trading profit for the year ended June 30, 1957, at £183,800 against £269,700 for 1956. The chairman said that they had signed a contract with the Finnish Government for the supply of twelve Gnat aircraft to be constructed at Hamble, together with a licence option for the manufacture of Gnats by Valmet Oy, a government-sponsored manufacturing company in Finland. He added that they had received substantial orders from Hindustan Aircraft for jigs, materials, etc., and they were then in the process of negotiating further orders of this type. They had also been in touch throughout the year with a number of other countries who were showing interest in the Gnat, and to whom they had offered advantageous delivery dates.

The aviation interests of the English Electric Company are represented by their aircraft division, by the Marconi group and by D. Napier and Son. The aircraft section was noticed in the last chairman's speech on the lines that orders at present on hand would keep the facilities employed for some years ahead, and also that they were spending further large sums of money on research equipment applicable to both aircraft and guided-weapon design.

Vickers' stake in aviation is under the heading of their subsidiaries Vickers-Armstrongs and Vickers-Armstrongs (Aircraft). The year 1956 was stated to have been one of continuing success for the Viscount, the value of all orders and spares being around £125,000,000.

Alvis was registered as a private concern in 1917 as Holley Bros., changed its name to T. & G. John in 1919, to Alvis Car & Engineering in 1921 and to its present title in 1936. Trading profits for the year ended July of 1957 were returned at the new high level of a shade over £569,000 against £456,400 for 1956. The former figure was the summit of a steadily firming trend evident since 1950, when the corresponding figure was only £81,700. The chairman said that their prospects for the current year appeared promising, and that the factory had a sufficient volume of orders in hand for aero engines and vehicles to keep it adequately employed throughout the year ending July 31 next.

In the components, equipment and materials sections of the industry the same upward trend of trading profits was also mostly evident.

Heston Aircraft and Associated Engineers, the latest recruit to public company finance, has three subsidiaries, only one of which at present trades and which sub-contracts to Westland Aircraft for the manufacture of helicopter components.

As will be seen from the table, two old-established manufacturers of aircraft finishes, Cellon and Titanine, both became public companies about the same time. Cellon returned their trading profits for 1956 as a shade under £171,000 against £199,300 for 1955, the latter being a new high level. The chairman said that in 1956 costs continued to increase, these being in so many cases beyond managerial control. Titanine's trading profits for 1956 were given as the new high level of £119,700 against about £107,000. The chairman's address here included the information that the demand for their aircraft finishes increased during the current year, especially in the direction of internal protective schemes for passenger aircraft.

In the electronic equipment and instrument section, an exception to the general trend was provided by Ferranti, with trading profits for the year ended March 1957 £1,121,000 compared with £1,836,000 for 1956, this latter being a new high record. The chairman said that they had supplied the Navy during the year under review with the first equipment forming a new blind-approach system for landing aircraft on aircraft carriers; and, further, that in conjunction with the Bristol Aeroplane Company, they were developing and manufacturing radar and electronic circuits, servo-mechanisms, gyroscopes and other highly specialized equipment for guided-weapon control.

SUB-CONTRACT, EQUIPMENT, ETC., COMPANIES

Name	Regd. as Public Co.	Authorized Share Capital	
		Then	Now
Airscrew Co. and Jicwood	1936	£175,000	£750,000
British Aluminium	1910	£1,300,000	£12,000,000
Cellon	1935	£170,000	£330,000
Decca	1929	£200,000	£3,058,000
Dowty Group	1936	£200,000	£3,000,000
Elliott Bros. (London)	1945	£500,000	£2,000,000
Ferranti	1905	£130,000	£3,500,000
Flight Refuelling	1954	£300,000	£690,000
Heston Aircraft	1957	£240,000	£240,000
H. M. Hobson	1935	£150,000	£1,000,000
Plessey	1937	£500,000	£2,450,000
R. B. Pullin	1937	£70,000	£600,000
R.F.D.	1936	£75,000	£600,000
Titanine	1936	£100,000	£160,000
Tube Investments	1939	£1,250,000	£23,000,000

Elsewhere, Decca showed trading profit for the year ended March 1956 at the new high record of £1,797,000 against £1,729,000. The Decca Navigator Company's profits were somewhat lower than those of the previous year, largely because of heavy expenditure in connection with the expansion of business on the air side.

The Dowty Group's trading profit for the year ended March 31, 1957, was returned at a highest-yet level of £1,982,800 against £1,715,000. The chairman said that while a decline in their military aviation business now appeared likely, this had not yet been reflected in the aircraft order-book. For the first time in their history they were supplying aircraft undercarriages built in this country to the U.S.A. for incorporation in the Fairchild-built Friendship, designed by Fokker of Holland, to whom they also supply undercarriages.

R. B. Pullin and Co., Ltd., and the Plessey Co., Ltd., both became public companies in the same year of 1937. R. B. Pullin

(*Concluded on page 1002*)

1956—Fairey flew fastest———

1957 Fairey flies the first Vertical Take-off Airliner

ADDING achievement to achievement, Fairey Aviation, holders for almost two years of the World Absolute Speed Record, have now built—and flown—potentially the most important transport aeroplane in the world, the Fairey Rotodyne.

Carrying 48 passengers or 4½ tons of freight it takes off vertically as a helicopter and having gained height flies forward as a normal twin-engine airliner.

It is the most adaptable rotary-wing aircraft in the world and the first to offer operating economy directly comparable to that of fixed-wing aircraft over ranges of up to 400 miles.

The arrangement within the Rotodyne's capacious fuselage can readily be adapted to suit civil or military applications.

Powered by two Napier Eland propellor-turbines with Fairey Pressure-Jets at the rotor-tips for take-off and landing.

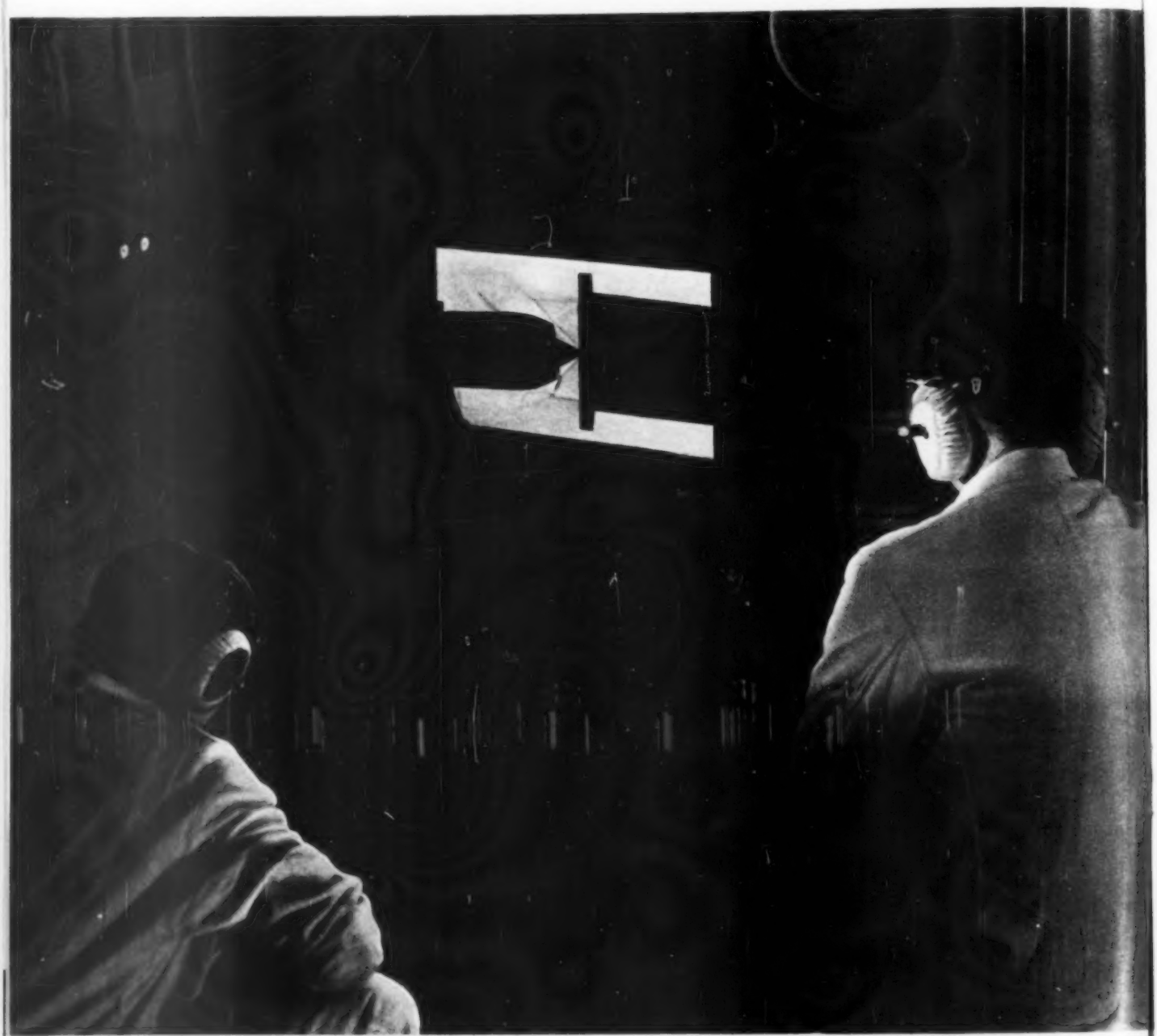
FAIREY *Rotodyne*

48 passengers · 185 m.p.h. cruising speed · 400 miles maximum range

THE FAIREY AVIATION COMPANY LIMITED · HAYES · MIDDLESEX

ENGLAND · AUSTRALIA · CANADA

DE HAVILLAND ENGINE RESEARCH SPEEDS THE WAY AHEAD



For optimum efficiency at high supersonic speed, the air-intake—no longer a simple engine component—itself requires considerable development effort.

Wind tunnel research undertaken by experienced de Havilland technicians in the Engine Company's laboratories provides precise aerodynamic information for the design of intakes with high pressure-recovery factors.

DH ENGINES

GYRON GYRON JUNIOR SPECTRE

Left, the prototype of a new version of the Finnish Valmet Tuuli trainer and communications aircraft. The engine is a Continental O-470. For training there are two seats; for communications, four. Note how the erstwhile British "P" symbol, signifying prototype, has been adopted and retained by the Finns. The second picture is a new view of the Lockheed F-104A Starfighter showing underwing, pylon-mounted tanks.

AIRCRAFT INTELLIGENCE

U.S.A.

North American T-28. The ultimate development of N.A.A.'s famed series of piston-engined trainers, the T-28 has for some years been an important basic trainer of the U.S. Air Force and Navy. Early versions were built for the U.S.A.F. at Los Angeles and Downey, and the late Navy versions have all been manufactured at Columbus. The last—a T-28C—was recently delivered from the latter plant; the total number produced was 1,948.

Retired Military Aircraft. The first Douglas Globemaster ever built is being placed in the Air Force Museum at Wright-Patterson A.F.B., Dayton, Ohio. This aeroplane was originally built as a C-74 in 1944 and was later rebuilt as the YC-124. It was accepted by the U.S.A.F. in 1951. The great Convair XC-99 six-engined transport, recently retired from U.S.A.F. service and put up for disposal, has been handed over to a section of the Disabled American Veterans organization in San Antonio, Texas, and will be maintained by them as a memorial to the Air Force, presumably not in full flying order. Like the first Globemaster, the first North American X-10 pilotless test vehicle for that company's Navaho missile has been sent to the Air Force Museum. One of 13 X-10s built and flown, this first machine still holds the record for the type by having successfully completed eight out-and-return flights.

France

Alouette II licence for Republic. Following demonstrations by two Sud Aviation Alouette IIs (Turboméca Artouste turbine) in the U.S.A., this type of helicopter is to be placed on the American market without delay. In a joint statement Mr. Mundy I. Peale, president of the Republic Aircraft Corporation, and M. Georges Hereil, president and general manager of Sud Aviation, have announced that the first example will be assembled and sold in the U.S.A. in accordance with the terms of a licence contract as soon as French-built parts arrive by air in America. Principal points of the contract are (1) the assembly, flight testing, sales service and maintenance of the Alouette II in the U.S.A. by Republic, and the construction in France of all parts, including the engine; (2) the production of the aircraft by Republic in the U.S.A. after an intermediary period during which a continuously increasing number of parts will be produced in the U.S.A. and incorporated with parts of French manufacture.

Max Holste Super Broussard. Since the type was exhibited in model form at the last Paris Salon, construction of the Super Broussard has been advancing rapidly at Rheims and various developments are announced. The military version is to have a new type of full-span leading-edge slot, and the aft fuselage section can be opened up by means of two doors to allow the loading of very long objects (about 21ft).

FAIREY GANNET T.5 (for West Germany)
(Armstrong Siddeley Double Mamba)

Span	54ft 4in
Length	42ft 11in

RAMJET DEVELOPMENT

Problems of Design and Testing Discussed in R.Ae.S. Lecture

A LECTURE on ramjets, read to the Royal Aeronautical Society in London on December 12 by Mr. R. P. Probert, is summarized below; the sections dealing with ground and flight testing are reproduced almost in full, but the earlier part of the paper covering performance and design factors and intake operating problems has been abridged. Mr. Probert is deputy director of the engine-test facility at the National Gas Turbine Establishment, Pyestock.

THE present time, when the prospect of high speed flight often seems to recede, not to approach [Mr. Probert began] may well be a good occasion to review the ramjet, an engine whose main use is at high flight speed. We owe the succinct name "ramjet" to the Americans and the original idea to the French. This paper is mostly concerned with British ideas, especially and naturally with those conceived and prosecuted at the National Gas Turbine Establishment.

Avoiding painful delusions about flying stovepipes, the ramjet consists of an intake or diffuser which converts to pressure some of the kinetic energy due to relative motion in flight and supplies the air inspired to a high-pressure combustion chamber, which in turn discharges hot gas rearwards through a propelling nozzle. Pressure ratio naturally increases with flight speed, presuming appropriate aerodynamic design; and overall efficiency, or thrust work per unit of fuel, can increase indefinitely with speed towards 100 per cent. Practical limits are set either by excessive ram temperature introducing an alien cooling load in the normally cool part of the engine, or by inability to cool with hot ram air the normally hot parts of the engine at satisfactory flame temperatures. But these difficulties do not arise until a Mach number of 4 is exceeded, and less conventional possibilities remain thereafter.

There have been many attempts to use the ramjet, often at a higher relative air speed than that of flight. For example, the Royal Aircraft Establishment quite early tried driving a propeller with tip ramjets and this has a modern counterpart in the ramjet tip-drive of helicopters, but with subsonic tip speeds the equivalent brake horsepower can only be obtained at 5 to 10 per cent efficiency, and such schemes depend upon the low weight of a simple engine giving relief from heavy fuel consumption for short endurance. During the 1939-45 war German invention was very active. Some serious, although inconclusive, work was done on subsonic engines, leading to trials in lorry dashes down an autobahn and, more usefully, on a Dornier. Another idea was to increase the range of a gun-fired shell by building a small ramjet around it and using ram pressure to expel a small liquid fuel charge. But the weight and size increase was obviously considerable and the technique a difficult one for the time, and the requirement was outdated before the device matured. We have our own record in Britain. One must admit the reduction of radiation drag by proper shaping of entry and exit ducting as prior art. More recognizable were attempts to give a temporary speed boost to wartime fighters by means of ramjets. These schemes, too, were overtaken by events and, although ground development was physically successful, nothing directly useful emerged in time to meet a fleeting need.

Only the guided weapon has as yet given the ramjet a real job to do. Here thrust deficiency at low speeds is immaterial and good economy, light weight and relative simplicity in the supersonic speed band make it an attractive motor for all but the shorter ranges, in which the solid rocket will serve.

Missile engines tend to be specialized. Their first job is to provide some acceleration or, at least, to hold speed in a steep climb. They work at high ram pressures near the ground and are able to put in kinetic energy low down to help ascent at high altitudes, where ram pressure, mass flow and thrust all fall in relation to weight. Thereafter they must maintain speed at lower thrust ratings against drag forces only. Their job and operating conditions, therefore, differ from those of prospective aircraft engines where the ram pressures must be limited by aircraft stress factors and high longitudinal accelerations are unlikely, though steady acceleration will be needed from the main engines. Since the war there has been widespread use of flight-test vehicles framed to provide a means of trying out ramjet propulsion techniques under representative conditions, and latterly, of course, some actual weapon engines. Now, individual missile or aircraft engines must be closely matched in size and operation to their special rôle or may even be integrated structurally and aerodynamically into the systems they power. The ramjet is, therefore, a subject where a wide variety of component techniques and operating phenomena deserve study because of the extreme range of possible requirements and methods of application.

The latent performance of a ramjet at any speed is set partly by pressure recovery, or internal aerodynamic efficiency, and chiefly by combustion temperature. Securing the performance depends upon proper choice of critical flow areas at inlet, inlet throat, and nozzle throat, and so on, to give proper matching of components.

It is possible to provide an engine which, simultaneously climbing and accelerating, provides roughly constant thrust over a large change of height. This latent acceleration and climb capability is a very handsome start to supersonic flight. If, now, at high speed the nozzle is closed and the temperature reduced (accompanied by closure of the intake) one can drop down to a quarter of maximum thrust, with a decrease of some 40 per cent in specific fuel consumption. Clearly an engine with fully variable intake-capture and throat areas and variable exhaust throat-area is an advanced one, although not necessarily difficult, and mechanically simpler engines may be discerned. A design of fixed intake area with a varying nozzle area can give good thrust and economy over the speed band and also efficient reduced thrust for cruising. Finally, there is our present-day workhorse, and fixed-geometry engine, which earns our bread and butter.

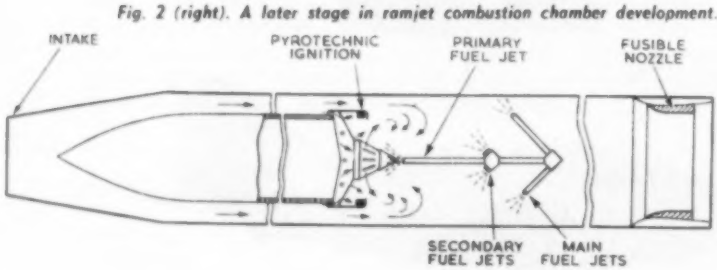
Without a variable nozzle it is impossible to match a fixed intake with a constant reasonably high maximum temperature over a speed range. If the design is biased towards good thrust at high speed the intake area is large, and spill or blow-off drag must be incurred at low speed, with loss in thrust and economy. If the design is biased towards low speed, the high speed thrust and economy are cut off by limited airflow, and the internal pressure must fall below maximum values to maintain choking velocities at the nozzle throat. In effect, shock and mixing losses are allowed to develop within the intake to reduce the pressure to the value matching the nozzle flow coefficient. If the temperature is reduced at high speeds this process can go a stage further towards lower thrust.

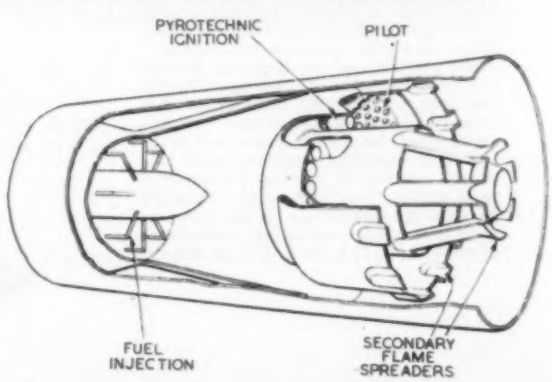
There are, then, these three main categories of engine ranging from the evidently mechanically complicated to the apparently simple, with concurrent deterioration in thrust and performance. Short-range-weapon engines are typically in the third class. In extenuation of the missile engine it must be pleaded that the fuel weight consumed is comparable to engine weight; and weight due to mechanical complication rapidly eats up fuel saving, especially since the engine does most work at the lower speeds and altitudes where its design is relatively efficient. This type of engine is, therefore, entirely right for its purpose, but it is not necessarily the easiest to develop. The more complicated versatile engines may well turn out to be easier after all.

In a fixed-geometry engine [continued Mr. Probert] working over a range of speed and thrust, the space distribution of mass flow from the intake varies enormously and is, sadly, beyond our ability to account for analytically. The professional aerodynamicist restricts himself to the serious problems and cheerfully leaves the distribution to be swept up and incinerated within the combustion chamber. Should the combustion system excel itself or, more likely, the control system lapse, thereby overdoing the temperature with reduction in mass flow, the intake reserves the right sometimes to

Fig. 1 (below). Final combustion chamber; an early development scheme.

Fig. 2 (right). A later stage in ramjet combustion chamber development.





go unstable. Providence surely intended better things and one longs for the day when mechanical ingenuity is allowed to provide adjustable throats and diffuser angles with improvement to flow distribution and matching.

Even a pitot intake, stable though it is on flow reduction and relatively insensitive to incidence, is not necessarily immune from supercritical operating troubles. We met one such difficulty while flying a test vehicle at Mach numbers above those we had at first been able to test on the ground. The particular intake configuration concerned consisted basically of a flat storage body, within the intake diffuser, splitting the duct into two passages. The pressure plots record measurements taken on a model at M=2.0 as the degree of supercritical operation increased or, if you like, as pressure recovery was allowed to fall off. Over part of the range of recovery values the flow split unequally between the two ducts; the duct with the lesser flow also gave the lower total pressure but higher static pressure, and this higher pressure seemed to extend forward to the plane of intake on that side. This suggested the shock pattern, and some quite simple two-dimensional calculations assuming this pattern, gave about 10 per cent agreement with the observed distribution of flow and pressure. Oddly, on winding up the pressure recovery again, the flow consistently split in the same manner, but with bias to the duct opposite to the case of decreasing recovery. No combustion chamber likes these flow variations, and a simple remedy was to extend a splitter plate forward from the storage body to the plane of inlet.

Dealing with intake instability the lecturer said that should an engine inadvertently enter the region of intake operation the flame might go out, the engine might continue to oscillate indefinitely, or it might recover with change of operating conditions. But most intakes [he continued] have some range of stable flow reduction at lower speeds and, accepting a loss of latent thrust somewhere over the flight speed band, operations can be planned to avoid the unstable region. A little interesting work has been done on an

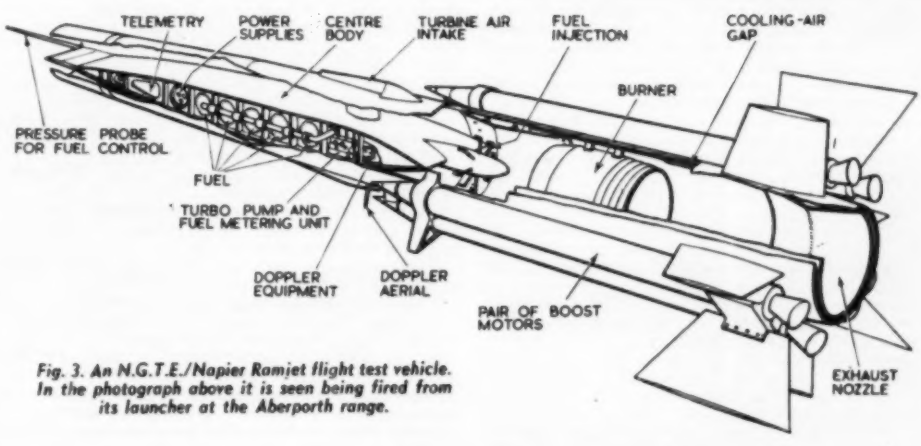


Fig. 3. An N.G.T.E./Napier Ramjet flight test vehicle. In the photograph above it is seen being fired from its launcher at the Aberporth range.

automatic stabilizer or "shock catcher" which can prevent the worst effects of intake instability. A plain cylindrical shroud of diameter greater than the inlet is mounted ahead of the inlet and an axial gap left between the two. This shroud adds only slight drag due to friction, and during normal operation of the intake it has no effect on its behaviour. Should the design shock system become unstable during oscillation, it enters the shroud and immediately "pops" forward to emerge as a normal shock ahead of the shroud. The system now acts stably as a pitot intake at lower recovery, and excess air the engine cannot swallow at this lower recovery is leaked through the axial gap. To return the system to normal duty fuel flow must next be reduced, while the total outflow area (bleed area plus intake throat) is closely explained by the minimum-contraction rules for internal-combustion intakes. After restarting, the mixture strength will be weaker than normal and the intake running supercritically, so the last action is to increase the fuel flow again towards the limit defined by intake stability.

Turning to combustion systems, Mr. Probert remarked that from the beginning, work at the National Gas Turbine Establishment had tried to establish a type of combustion system adaptable, with variations, to all these needs, and the constant theme had been the use and improvement of pilot systems. The simple idea here [he went on] is to divert a fraction of the air into a sheltered region, physically separated from the main flow, in which lower mean axial velocities are maintained and where fuel concentration and gas mixing patterns can be reasonably well controlled within the pressure drop available. Having created a stable flame, efficient under all operating conditions, it is used to ignite the remaining fuel and air by-passing the pilot. This constitutes a two-stage system where thrust is altered by cutting off fuel supply to part of the by-pass air only, still leaving the cruise fuel to burn at optimum conditions throughout the thrust range. This technique is now very widely used and seems obvious, but its virtues were not always universally seen or admitted.

The pilot has taken different forms with growth of understanding and experience over an ever widening range of operating conditions. The first scheme, successful for its day, is illustrated in Fig. 1. The limit to baffle diameter was set by expansion loss in the flow around it, and this pressure drop was used to force air through the baffle at several places in such a way as to maintain continuous ignition by recirculation of burning gases. A pressure jet sprayed fuel symmetrically into the recirculation zone while secondary and tertiary fuel was sprayed at stages downstream. [A greater-flow pilot, on which a lot of experience has been accumulated, is illustrated in Fig. 2.]

For the best practical results an unprejudiced approach is still the best. One example of the puckishness of combustion system design was this. Excited at the prospects illuminated by recent researches, we modified a working combustion chamber to incorporate the best pilot that empirical theory could propose. Surprisingly no change in overall performance could be detected, but the fatigue life of the pilot was usefully extended due to the more regular metal-temperature patterns set up; an unexpected bonus but very gratefully received.

For ground development a ramjet must have independent air supply and exhaust services. This bitter necessity was always an argument against the ramjet, but, ironically, the bulk services it really required awaited the day when the turbojet, finding its own

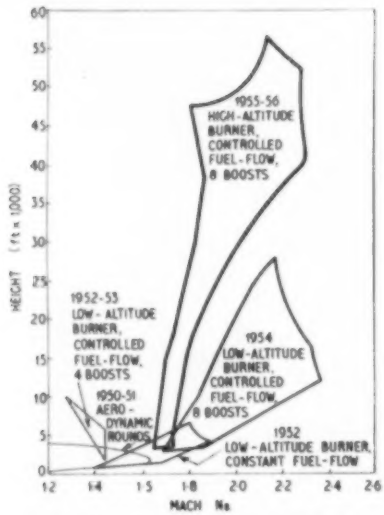


Fig. 4 (left). Flight envelope of test-vehicle trials with various combustion and fuel systems.

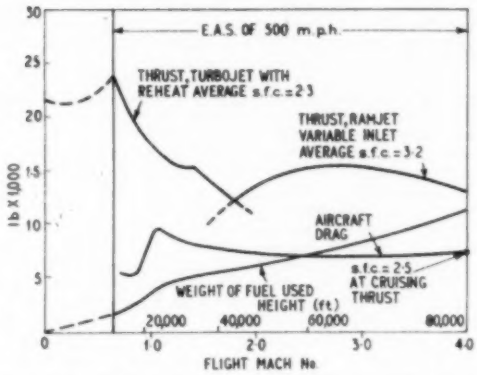


Fig. 5 (right). Thrust and drag patterns of a hypothetical aircraft (a.u.w. 50,000 lb).

RAMJET DEVELOPMENT . . .

progress hindered by the same restrictions, commanded and shared even larger resources. Indeed, to retain his title the early ramjet exponent had to be a real improviser.

Those hands not scooping air from all Hampshire and puffing it through engines on ground test took an occasional sacrificial engine to the coast. Hurled violently from a cliff, it clutched at brief distinction before plunging into an inscrutable sea, while whisps of telemetry bore back the riddle of its progress. No cosseting in cosy flying test-beds for the ramjet.

However, times have changed and we now possess in Britain elaborate and versatile ground test equipment designed for the job. One example will serve. There is now a new free-jet altitude cell at Pyestock. A free-jet nozzle is mounted on an articulated pipe system and directs a supersonic air stream towards the engine intake at varying incidence. The air jet can be supplied at any total pressure up to six atmospheres and at temperatures up to 300 deg C. Equivalent speeds and heights up to M=3.0 and 70,000ft can be fully simulated. A bigger jet is blown at the engine than it consumes, so that intake shock reflections do not disturb the intake flow and the excess or "spill" air is efficiently diffused to mix later with the engine air discharged at the exhaust throat, and so reduce plant capacity demands. Techniques of "spill" diffusion have been intensively studied and those in use now are thought to be as efficient as possible. The process is a complicated one, since the spill flow characteristics depend upon shape, Mach number, spill quantity, incidence, and engine intake design and operation. A simple system is in use for testing at successive fixed Mach numbers of operation. The practice is to move the diffuser lip section forward to open up throat area for starting. It is advantageous in reducing pressure ratio demand for starting and for operation at incidence, to bleed some flow at true altitude pressure from the space around the jet and pump this separately back to the diffuser exhaust. Using all these aids, the pressure ratios required for testing approach those of wind tunnels, where only small disturbance is caused by the test model to the diffuser flow. More versatile systems using rectangular geometry providing continuous and rapid change of test speed, height and incidence, have been studied in detail and are now designed but not yet built.

Ramjet flight testing confronts the research engineer with an agonizing dilemma. He is not producing an article for regular use under defined conditions; he must try new things, test their capabilities and his understanding, and let practice sharply teach him right and wrong. In ramjet research trials human lives are not at stake, although human reputations possibly are, and every engine in ballistic trials is destined for loss on return to sea level; one is, therefore, uniquely free in every trial to reach the limits of failure in performance or mechanical operation. Each flight should carry graduated risks of several different kinds to explore extremities in many aspects of design and operation. The art is to arrange that any total failure will be due to the last risk taken. But logic never rules; conscience must sometimes yield to the prejudices and necessities of life. One must put up an occasional dull success to buy time for a batch of intriguing failures.

Fig. 3 shows the test vehicle used by N.G.T.E. for flight trials. It was first designed at N.G.T.E. and has since undergone continuous development at the hands of the Establishment and D. Napier and Son, Ltd., by whom it is manufactured. Its objects were to try out combustion, fuel control, cooling and intake techniques in flight, to confirm, deny or extend ground results and, above all, to throw up the working problems of application and keep research and development on a realistic basis. The flight envelope chosen was speeds up to M=2.5 and heights up to 60,000 to 65,000ft.

It began as a 600 lb dart accelerated by four forward wrap-round boost rockets weighing 800 lb, to a launch speed of M=1.55; a light, cheap system. This arrangement was made to work, but uneven thrust decline of the separate boost motors led to excessive pitching of the dart at boost separation, with attendant protest by range staff and loss of control of the required flight trajectory. It now flies with eight rear wrap-round boosts of 1,800 lb weight in a lengthened version of 950 lb weight to the higher launching speed of about M=1.75. The vehicle is about 20ft long and 18in overall diameter. The front is a steel shell comprising intake and ducting spanned by a flat centrebody housing fuel, pumping and control gear, instrumentation and radio transmission apparatus. The rear is a steel monococque carrying stabilizing fins, boost combustion unit, liner and nozzle.

A total of about 30 launches has covered many aspects of the design and operation of engine components and of the vehicle and its equipment as a flying tool. Besides many small but important details of construction and operation, the major test variations have included: (1) Two radically different boost separation techniques. (2) Five fuel-system stages, starting with gas pressurization and constant fuel flow, first adding ignition flow control, then mixture control for acceleration; later substituting pressurization by an air turbine-pump with speed control, and finally substituting a two-stage fuel system with cruise thrust and flight speed control. (3) Four combustion chambers with successively improved standards of thrust and altitude performance. (4) External and submerged wall cooling systems. (5) Three instrumentation layouts. (6) Three intake and exhaust area configurations giving different overall engine characteristics. (7) Four trajectories and durations, or sets of flight operating conditions.

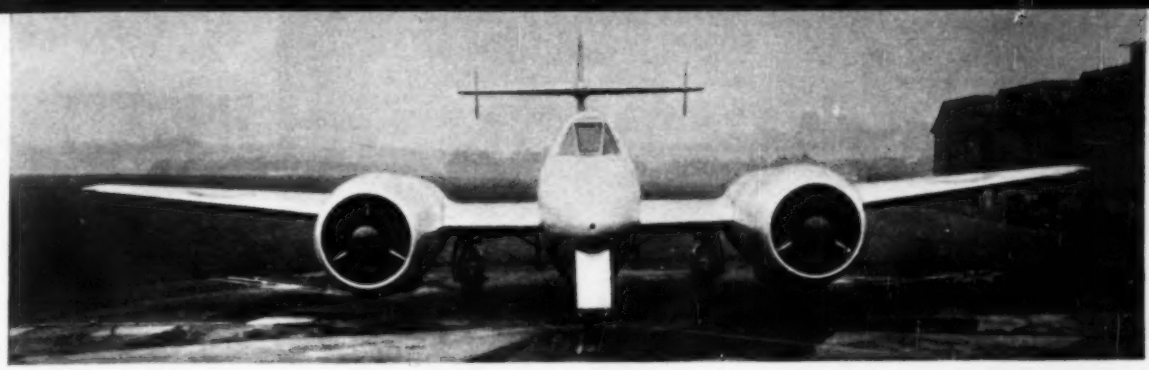
In fact, roughly one major change per flight was made to the engine, the vehicle, the equipment or the flight envelope, and each one was equivalent to roughly ten permuted flights on the shot-gun technique. This could only be done by treating each trial as an elaborate, specialized affair based upon the sum total of previous data and experience, to be followed by detailed study of the flight records and intensive ground checking of any observed flight peculiarities. One can then leap-frog economically over groups of issues together. It calls for flexibility and unnatural forgiveness in drawing offices and shops, but these virtues our associates at Luton possess.

Regrettably, one trial was a perfect, unblemished success; obviously we picked too easy a target and wasted a round. In eight trials we did a little better; they, too, were evident successes, but we found a few useful private snags. Another ten were tolerable compromises and of the rest, five were really fine failures stimulating streams of inquiry, speculation and invention.

Fig. 4 shows the record of speeds and heights covered so far. By arithmetic it seems that, on average, height has increased at 2,000ft per trial and speed at M=0.03—dare we assume that another fifteen trials will get us near M=4 at 90,000ft?

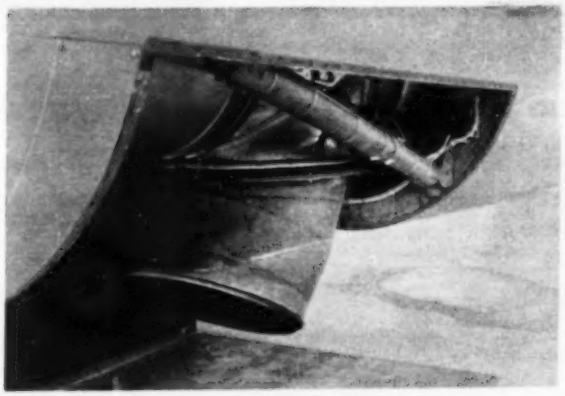
The uses of a test vehicle need continuous debate, although it should be remembered that the profits are sometimes unexpected ones. This vehicle has regularly (sometimes irregularly) operated at the higher ram temperatures and pressures, Mach numbers and degrees of supercritical operation which we are only now able to achieve on the ground. This certainly added confidence in ramjet capabilities and drew attention to points of design or operation needing further study in full scale or model test rigs. But this particular qualification is now lost for this particular vehicle with recent rapid improvement in ground test equipment. It also confirmed that ground simulation techniques for the complicated dynamic process of ignition, especially at supersonic speeds, were reasonable guides to flight performance. It has forced some clearer thinking on the effects of high transient g on fuel system operation. It taught a sharp lesson on the sources and cumulative performance effects of small air leakages in light construction. It taught the practical limitations of the most efficient boost techniques and sponsored some understanding of the complicated kinematics of the process. It made us learn how to install electronic equipment to work

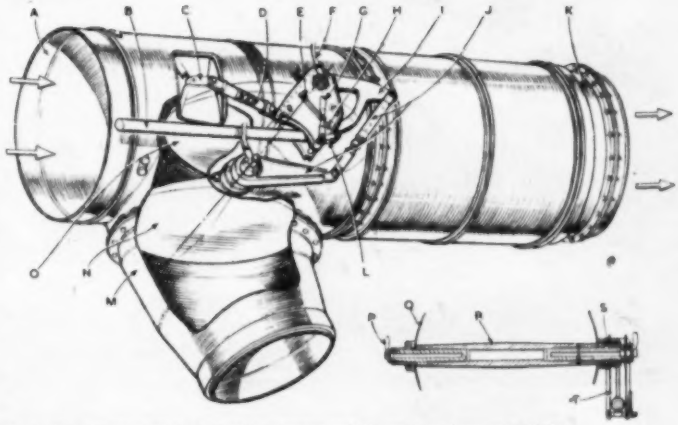
(Continued at foot of opposite page)



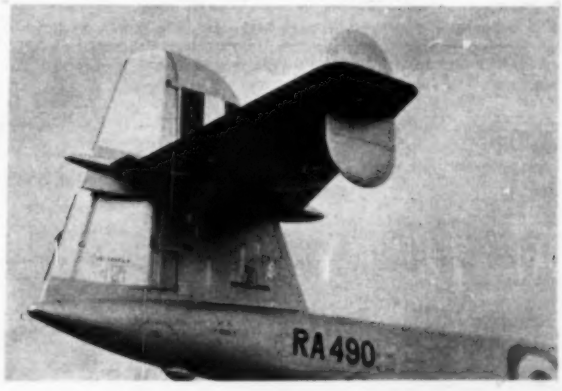
N.G.T.E. METEOR

FIRST pictures of the jet-deflection Meteor were published in our issue of February 18, 1955, but here are the first to be released showing the actual mechanisms of the deflection boxes. As the drawing makes clear, the jet from each engine can be deflected through almost 80 deg to provide increased lift. The aircraft is Meteor 4 RA 490 (once fitted with Avons). For the jet-deflection experimental programme it was equipped with a pair of Rolls-Royce Nenes, together giving thrust almost equal to the aircraft weight. The National Gas Turbine Establishment, who managed the programme, designed and built the deflection boxes, while Westland Aircraft undertook design of the controls, installation of the complete powerplants and certain airframe modifications.





A, engine attachment; B, hydraulic actuator rod; C, main anchorage; D, link; E, upper deflector-vane axis; F, bearing pressure pipe; G, microswitch link; H, lock spring; I, upper-vane lever; J, lower-vane levers; K, jet-pipe attachment; L, end cam; M, deflector pipe; N, lower deflector vane; O, upper deflector vane; P, bearing pressure pipe; Q, deflector-box casing; R, deflector vane; S, shaft bearing; T, lock housing.



The heading picture shows Meteor RA 490, emphasizing the bulky nacelles for the Nene engines. Above is a close-up of the downward nozzle from one of the deflection boxes, the resultant thrust from which acts through the aircraft c.g. The additional fins (lower right) were added to provide adequate control at the reduced flying speeds which could be obtained. A complete deflector box is shown in the annotated drawing; the small inset is a deflector vane in cross-section.

RAMJET DEVELOPMENT (continued from opposite page)

in the pressure and vibration field of the engine. It has confirmed many combustion, control and cooling techniques, but especially, it has forced the habit of precise accounting of these matters over the whole field of operation.

This type of vehicle chiefly solves functional problems. With the experience now gained, and, we hope, most of these lessons learnt, and possessing new versatile ground test equipment, the utility of ballistic trials is rapidly decreasing. Further progress turns upon variable geometry, internal compression intakes and so on, and emphasizes intricate problems of control and endurance, requiring accurate observations of a more scientific pattern. But, it must be asked, will it all be worth while?

Fig. 5 attempts to vivify the real point of a ramjet as a true aircraft engine. In a climb at the modest E.A.S. of 500 m.p.h. it shows the decrease of fuel load and the patterns of aircraft drag and engine thrust. It presumes a reheated turbojet for speeds up to about M = 2.0 and a variable intake ramjet thereafter; the two engine thrust characteristics match remarkably well. Moreover, the intake and exhaust area requirements are the same for both engines at the transition speed. The intake and exhaust systems can, therefore, be shared and in principle the ramjet combustion system could be used as the reheat system of the turbojet. Two vital points are, the roughly constant thrust characteristics of the ramjet, which behaves in climb and acceleration like a super-efficient rocket and the large excess of available thrust over cruising drag. For little extra weight over normal take-off powerplant requirements, the ramjet can "tack-on" to the take-off engines and deliver the aircraft promptly to guaranteed speed and height, irrespective of likely aircraft weight and drag variations. By closing the exhaust nozzle at top speed the cruising s.f.c. drops to about 2.5, representing a modest 40 per cent overall engine work efficiency compared with the target of 50 per cent suggested earlier.

Reflecting on the fuel consumption pattern it seems that unreheated turbojets, or rocket-derived engines with s.f.c. of 4.0 or more, if used as alternative take-off engines, are unlikely to cancel respectively their extra engine weight or fuel consumption during climb. In descent or stand-off the ramjet-turbojet combination could operate as a plain turbojet with adequate thrust and good economy.

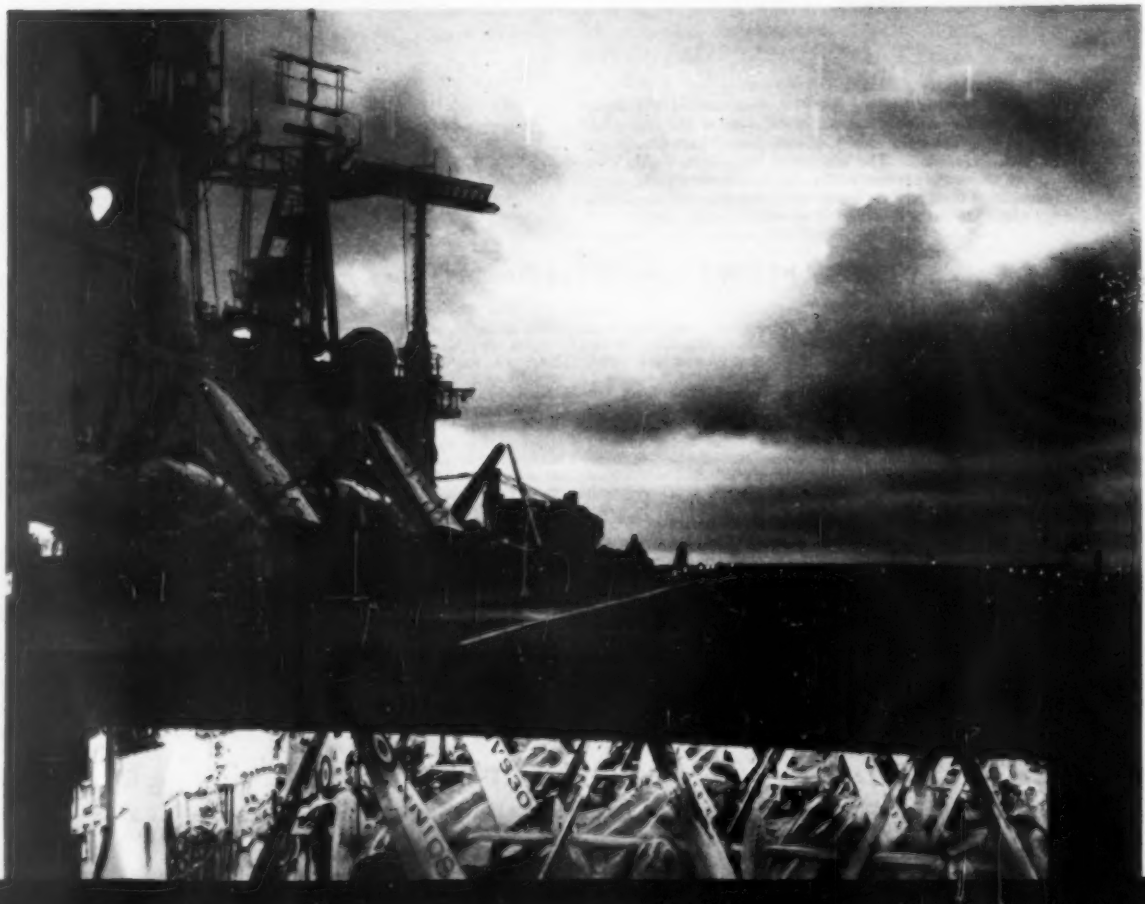
The ramjet has outgrown the uncertainties of youth and confidently seeks new and challenging enterprises. If high cruising speed and operating height are wanted, the ramjet is willing and able to serve. But for purely economic flight it would be naïve not to recognize that high engine efficiency is useless if it can only be achieved at flight speeds involving prohibitive loss in lift drag ratio or structural efficiency. In the flight example given it is the drag characteristic which most needs improvement. Perhaps this will come from variable wing-geometry, or part-ballistic flying, or structural and aerodynamic integration of engine and airframe. The end point of ramjet development and the greatest prizes it offers will only be achieved by a change in convention.

"Flight" photograph

"Flight" photograph

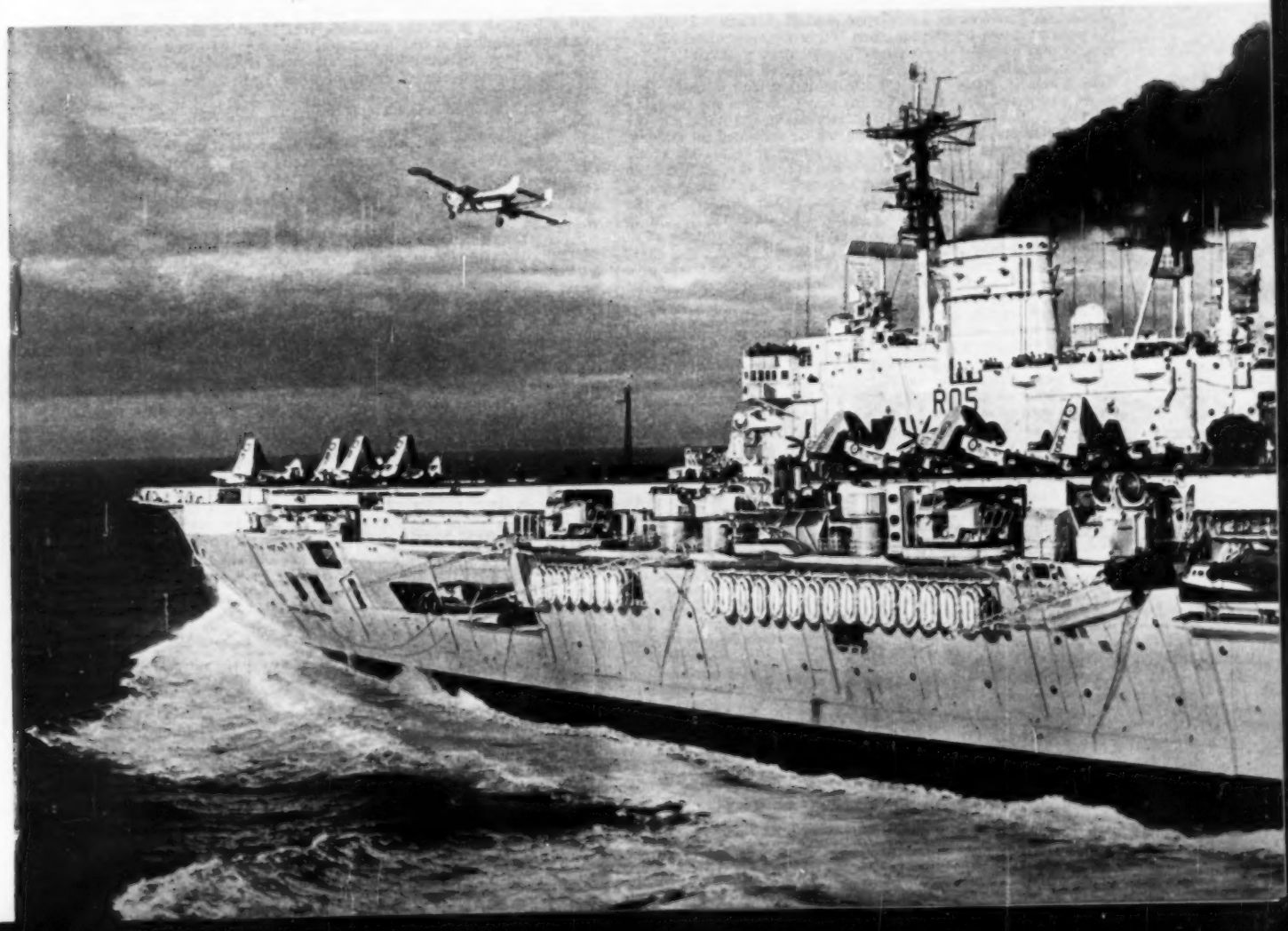
AN AIRFIELD AT SEA: the grim beauty of day-and-night operat

These dramatic photographs were taken recently in the 46,000-ton fleet carrier H.M.S. "Eagle" during the course of her autumn cruise, which included participation in several exercises and a visit to Vigo. She carried six types of aircraft, four of which—Sea Hawks, Sea Venoms, Wyverns and Gannets—appear in these pictures. The night scene below may appear momentarily puzzling to the uninitiated: taken from the edge of the forward lift-well, it affords a glimpse of Sea Hawks in the brilliantly lighted hangar. "Eagle" is now in harbour with her squadrons dispersed to their home stations for Christmas leave. An illustrated description of a visit to the ship at sea appeared on Nov. 8.



"Flight" photograph

operations from an aircraft carrier



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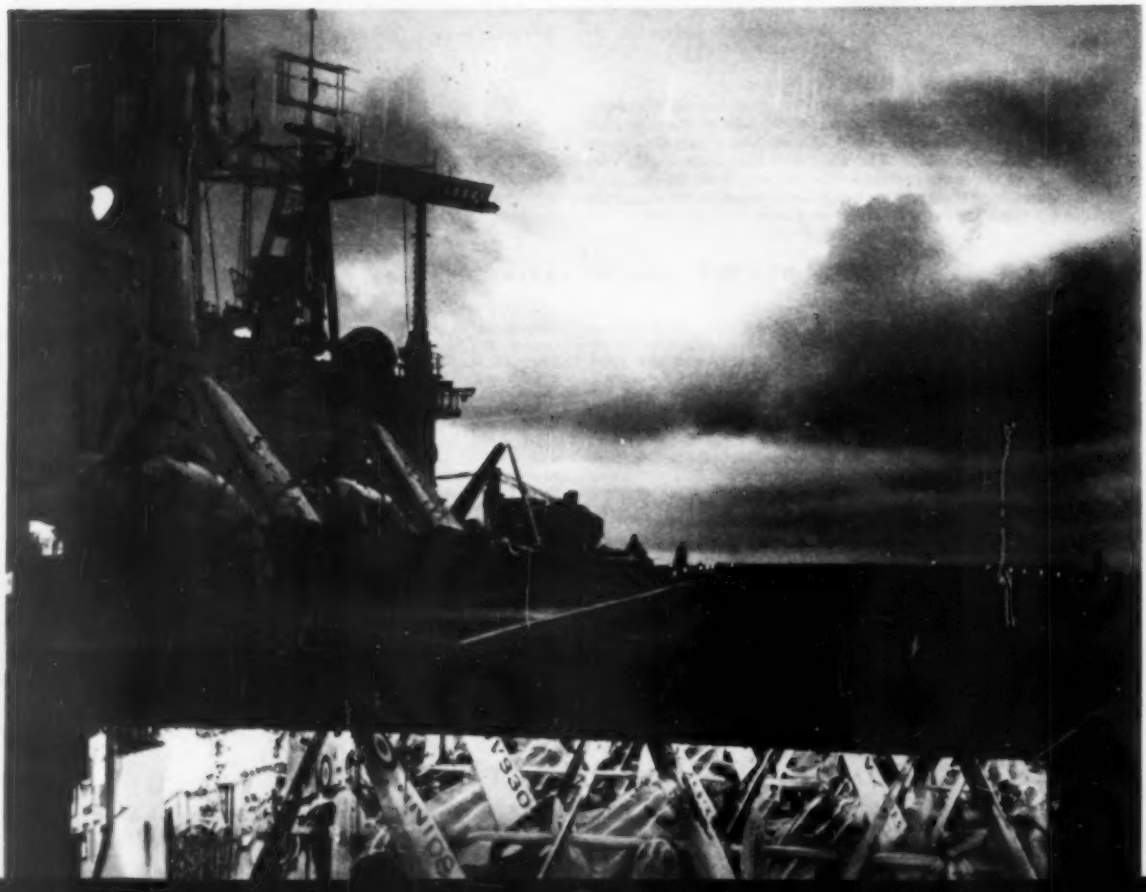


"Flight" photograph

operations from an aircraft carrier

RW3 Multoplane

Unique Combination of Self-launching Sailplane and Efficient Aeroplane

"The tricycle undercarriage is really low."

By O. W. NEUMARK

IT looked strange, even in the company of all those exotic shapes at the Paris Aero Salon. On closer examination, it seemed to combine all desirable characteristics, however contradictory, which had ever been conceived for a practical and economic means of transport for two, for a fully aerobatic light aeroplane or for a two-seater sailplane with continental touring capabilities. Naturally, with so many new missiles about, it received an unfairly small share of publicity. It was the RW3 Multoplane.

Its chief designer, Herr H. O. Fischer (a war-time fighter pilot) explained to the writer how so many conflicting requirements had been satisfied in one airframe and very kindly invited him to fly and soar in it when it returned to its base in Wahn.

Some months later, the opportunity occurred. I met Herr Fischer (together with Herr Gomolzig, who was responsible for the design of the undercarriage) and the RW3 in its hangar. It was already rigged but, where hangar charges are based on a span × length formula, its wings can be folded along the fuselage to occupy no more space than 24ft × 6ft. In this folded configuration it can be towed behind a car by means of a simple bar attached to the nosewheel. Similarly, if it lands as a sailplane in a field too small for a subsequent take-off, it can be folded up and pushed along on its own undercarriage through gates and along roads until a suitable take-off field can be found. Rigging can be performed by two persons within ten minutes.

The hangar doors were not fully opened but, rather than open them, Herr Fischer preferred to demonstrate how one person could manœuvre a 49ft-span aircraft through a 25-ft gap. He pressed down on the fin, thus lifting the nosewheel off the ground and wheeled the machine out in three traverses.

Once outside, the RW3 could be examined more thoroughly than it was in Paris. The tricycle undercarriage is really low, as its size is not determined by any considerations for propeller clearance. Rubber pads under compression in tubes are the shock-absorbers, and the nosewheel can be unlocked for taxying. There is a sprung skid for landing in ploughed fields, soft sandy beaches, mud or snow. Such arrivals are, of course, liable to occur when it is being used as a self-launching sailplane under F.A.I. competition rules. (These rules, which require that the means for restarting the engine in flight be removed, appear to be rather severe; surely a mere disqualification in the event of the pilot restarting the engine would suffice?) Two downward-hingeing panels immediately behind the main undercarriage give reasonable access to the 65 h.p. dual-ignition development of the standard Porsche flat-four air-cooled car engine. Within seconds, the Perspex canopy and the polyester-glass-fibre dorsal section can be removed, revealing the upper part of the powerplant, the steel-tube fuselage structure and the car-type transmission shaft from the engine to the propeller in the tail-slot.

The nose and side sections of the fuselage, also of glass-fibre, can be removed just as easily, only the lower rear fuselage sides and the control surfaces being fabric-covered.

The all-metal wing consists of two main sections which, with wing-tip tanks, give a span of 33ft (or 49ft with two additional wing-tip sections). With the short span the aircraft is fully aerobatic; while limited aerobatics and cloud flying are permitted with the long span. The same laminar-flow aerofoil section is used throughout the span, and flaps extend over the entire trailing edge up to the ailerons. The metal skin of the wing is backed by foamed polystyrene, which ensures that the wing surface remains smooth under load.

The main fuel tanks are in the wings and have a capacity of 13.2 gallons. The wing-tip tanks have an equal capacity. These may be retained as underwing tanks with the long span but for soaring flight would, of course, be dispensed with. With its low consumption on cruising power, and without considering any economy which can be achieved by soaring, endurance of the long-span version on internal tanks and on underwing tanks is respectively 4½ or 9 hr and range 450 or 910 miles. The short-span version claims a maximum range of 950 miles, but this is far outweighed by the capability of the long span to reduce fuel consumption by soaring.

For my first flight, Herr Fischer occupied the front seat and I strapped myself into the rear seat. Dual flying controls and throttles are fitted but all instruments and other services are in the front. As the second pilot's head is much higher than that of his companion it is quite easy to read most of the instruments from the back; but there is more than enough room for a full panel and radio—and even for small luggage—beside the rear pilot.

The engine started like that of a good car at the first touch of the starter. Taxying was a revelation—the field of view, even from the rear seat, was without any restriction and one felt entirely secure while taxying and turning at speed. Before take-off, 15 deg of flap were selected and the undercarriage-retractor torsion spring was cocked by pulling a long lever.

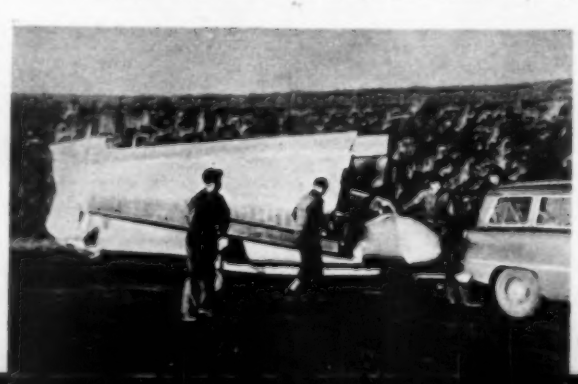
On release of the brakes the acceleration was quite reasonable for the very quiet 65 h.p., and after a run of some 200 yards into a 5 m.p.h. wind the machine was lifted off at about 47 m.p.h. and climbed at 600 ft/min and 55 m.p.h. As a new engine had just been installed, the throttle was treated very gently and the published rate of climb of some 1,150 ft/min was not demonstrated.

The elevator and aileron controls were light and well harmonized but, owing to its position in the slipstream, the rudder was very firm. The "stick-free" static longitudinal stability with a period of about 20 sec, was surprisingly good. In turns stick force increased with g. Rate of roll from 45 deg of bank to 45 the other way was achieved in just under 4 sec, and in 4 sec with engine off. The cruising speed of 115 m.p.h. at 77 per cent of 65 h.p. was quite impressive.

At 2,500ft Herr Fischer switched off the ignition and then aligned the propeller in its slot by touching the starter. The aircraft handled as before, except that the rudder now felt much softer and had to be used more vigorously to achieve maximum rate of roll. One's impression was that the best gliding angle of 1 in 25 at 77 m.p.h. with 4½ ft/sec sink was a reality and not a mere dream. On the other hand, one would have liked to have flown the Multoplane without the underwing tanks in rough and narrow thermals to see how slowly and tightly one could circle. Without flap the turns were certainly too wide, but with 20 deg of flap they appeared to be quite acceptable at 45 deg of bank and down to 50 m.p.h.

At 500ft over forested hills, I was much relieved to hear the engine spring into life at the first touch of the starter. Approach was steep with full flap at just over 50 m.p.h. and touch-down at 40 m.p.h. Fischer then took off again and, keeping the wheels a foot or so above the runway, maintained the I.A.S. at 35 m.p.h. After turning on to an intersecting runway he retracted the flaps and taxied at 55 m.p.h. and turned on to the taxi-track at well over 45 m.p.h.

I now settled down in the front cockpit with Herr Gomolzig

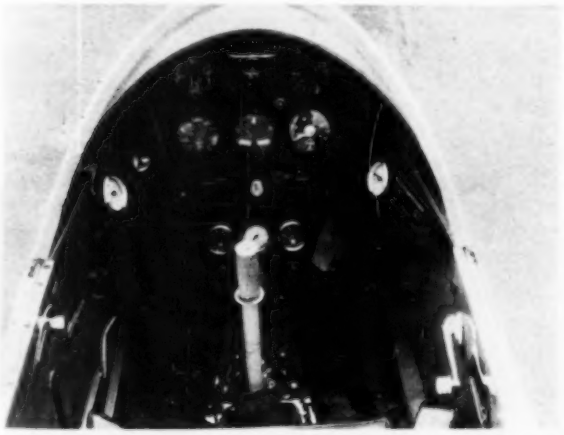


(Left) The author, in the front seat, and Herr Fischer. (Right) With wings folded, the Multoplane can be towed behind a car.

behind. In front, one sat even closer to the runway and I was again amazed by the taxying performance made possible by the unlimited field of view, the extremely low tricycle undercarriage, the effective rudder in the slipstream, and the brakes. During fast cornering one felt as secure as in a low-slung sports car.

Now for take-off. Check undercarriage retractor spring cocked, fuel contents, flap 15 deg, trim neutral, nosewheel locked by the small lever on the control stick. On opening the throttle, not the slightest sign of any yaw. I kept the aircraft down slightly longer than Fischer had done and lifted it off its nosewheel after some 300 yd at over 50 m.p.h. On release of the undercarriage catch the wheels snapped into the fuselage with a healthy bang and the immediate acceleration was quite noticeable. Winding up the flaps produced a barely perceptible change in trim.

Long-span version of the RW3, with underwing fuel tanks.



"Dual flying controls and throttles are fitted but all instruments and their services are in the front. . . ."

". . . dorsal section can be removed, revealing the upper part of the powerplant." Note the mounting of propeller and shaft.

This time we flew towards Cologne and over its outskirts passed a circling buzzard who had discovered the day's one and only thermal. Unfortunately it was a very weak one, and for some ten minutes we just maintained height while circling at 50 m.p.h. with 20 deg of flap. I then again convinced myself that the rate of roll with and without flap was in no way inferior to that of an Olympia. Throughout, the wing surface remained innocent of any wrinkling whatsoever. A straightforward sailplane approach was made at a reasonably steep angle with full flap; the aircraft then floated a few inches above the runway until it sat down of its own accord.

Summing up, the RW3 is a quite extraordinary powered aircraft offering unprecedented safety (all-round vision, safe taxying, ability to land in small ploughed fields on its skid without risk of overturning or damage to the propeller); economy (24 × 6ft hangarage requirement, low fuel-consumption, inexpensive but reliable engine, metal wings and structure fit for the worst climates); and good performance (on only 65 h.p.).

For a soaring group wishing to realize Wolf Hirth's dream of *Wandersegelflug* it is the ideal aircraft. One would, of course, install an artificial horizon in the front, a limited panel in the rear, and a finer-pitch propeller to improve take-off and climb at the expense of top speed, and only use a limited fuel reserve while soaring. It could enable a private-owner group to achieve a quite unheard-of amount of high-performance soaring. For instance, if the weather forecast for the weekend was poor for England but good for France, two pilots could fly to Northern France on the Friday evening and, weather permitting, each in turn make a 500 km flight and yet be back in England before midnight on Sunday. Again, one can envisage more leisurely soaring tours of the Continent, and even intercontinental tours without any complicated organization of cars, trailers and car ferries.

While its minimum sink is rather high for average English thermals, it should be remembered that each take-off is the equivalent of an aero-tow to the best cloud in sight. When meteorological conditions preclude soaring of any kind it can be fully utilized for *ab initio* flying or gliding instruction or more advanced blind-flying or unlimited aerobatics.

Unquestionably the most promising application for the RW3 lies in the field of practical meteorological research on the problems of standing and moving waves. If flown solo by a pilot in a pressure suit it would be able to carry the necessary weight of liquid-oxygen equipment—and might yet beat the World's Absolute Altitude record, now held by a Canberra, by soaring in the standing waves behind the Southern Alps in New Zealand. It could well be expected to win a number of other world soaring records, thanks to its good penetration and even more to its unprecedented ability to be in the air in the right place and at the right time.

The name "Multoplane" (presumably Esperanto for "multi-purpose aircraft") seems well justified. This little aircraft, one feels, is the most practical and economic solution for countless specialized functions such as bird-flight and migration research, forest fire and game conservancy patrols, A.A. and police traffic-flow observation, Press and small-scale aerial photography; and last, but not least important, it offers the perfect economical substitute for an "all-jet" training programme, since it handles like a jet in many essential ways.

Herr Fischer and his design team can be congratulated not only on having developed such a remarkable and promising aircraft incorporating so many novel design features but also in their faith and perseverance which has brought their project into the large-series production stage.

RW3 Multoplane (65 h.p. Porsche Type 678/0 four-cylinder engine)

	Long-wing version	Short-wing version
Span	49ft 3in	32ft 10in
Length	24ft 4in	24ft 4in
Height	6ft 11in	6ft 11in
Empty weight	1,280lb	1,210lb
Normal flying weight (solo)	1,500lb	1,500lb
Normal flying weight (dual)	1,675lb	1,675lb
Max. permissible weight	1,940lb	1,940lb
Wing loading (solo)	7.8 lb/sq ft	9.6 lb/sq ft
Wing loading (dual)	9.7 lb/sq ft	10.8 lb/sq ft
Wing loading (max.)	10.1 lb/sq ft	12.9 lb/sq ft
Wing area	194 sq ft	151 sq ft
Aspect ratio	12.5	7.15
Power loading	23.2-29.8 lb/h.p.	23.2-29.8 lb/h.p.
Take-off and landing speed	40-47 m.p.h.	47-53 m.p.h.
Rate of climb	11.5ft/sec.	9.8ft/sec.
Top speed	124 m.p.h.	132 m.p.h.
Cruising speed	112 m.p.h.	118 m.p.h.
Ceiling	18,000ft	14,800ft
Best gliding angle	1 in 25	1 in 16
Minimum sink	4.1ft/sec.	5.9ft/sec.

Take-off power: 65 h.p. at 4,500 r.p.m. (2,650 propeller r.p.m.), cruise power: 50 h.p. at 4,080 r.p.m. (2,400 propeller r.p.m.), fuel consumption (cruise): 2.75 Imp. gal/hr.

Manufacturers: Rhein-Flugzeugbau G.m.b.H., Krefeld/München Gladbach Krefeld-Urdingen, Arndtstrasse 60.

CZECHS AND POLES

An East European Miscellany

ON these pages we present a selection of photographs of recent products of the aircraft industries of Czechoslovakia and Poland. Most of the aircraft built in these countries are of Soviet origin, one of the most important being the LIM-2 (Mig-15), powered by the Nene-derived WK-1 engine and built at the former P.Z.L. plants located at Warsaw and Mielec (**picture 5**).

Both Poland and Czechoslovakia use military and civil Il-14 transports. Photographs show a standard example in service with L.O.T. (**11**), the Polish airline which will operate these aircraft into London before April 1 next, and one of the first Avia 14s to be completed in Czechoslovakia, and bearing military markings (**10**).

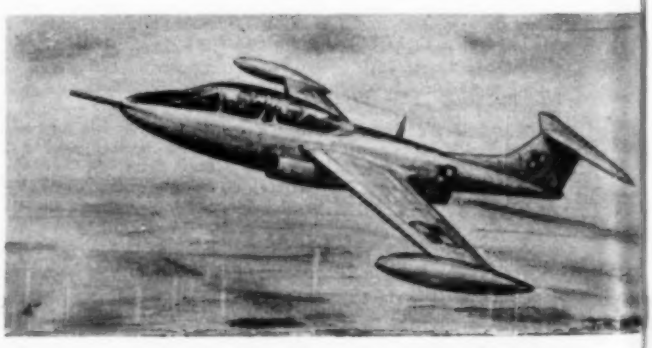
Standard trainer of the Czech Air Force is the Russian Yak-11, built as the C-11 (**14**). Bulk delivery began just one year ago. The C-11 weighs 5,512 lb loaded, has a span of 30ft 10in and cruises at about 205 m.p.h. on the power of an ASh-21 radial of 700 h.p. The C-11U (**13**) is also in service in small numbers, having a lengthened fuselage and a nosewheel.

To replace the obsolete Czech C.2B (Ar 96B), Ing. Tomas designed the TOM-8 multi-purpose basic trainer (**2**), which can be equipped with bombs and fixed guns. The sole prototype weighs 3,043 lb loaded, has a span of 34ft 5½in and cruises at about 133 m.p.h. (maximum, 174) on its 235 h.p. M-208C engine. Generally similar in function is the Polish TS-8 Bies (illustrated in our May 31 issue), and a replacement for the Bies is the TS-11 Iskra, of which a sketch appears here (**4**). Powered by a Polish turbojet of some 1,700 lb thrust, the TS-11 has been designed by Soltyk; the prototype should fly in 1959 and be capable of 530 m.p.h.

The Soviet An-2 (**1**) is a large and capacious biplane with a 1,000 h.p. engine; a picture shows one of a number used in Poland for parachute training and a host of other domestic duties. Standard Polish ambulance is the locally-built Yak-12M (**3**), also of Russian design, which replaces the CSS-13S (licence-produced Po-2). A notable Czech design is the Ld 60 Brigadyr (Agricolta), pictured in a crop-spraying role (**6**). Powered by a 220 h.p. Praga Doris B engine, the Ld 60 weighs only 3,020 lb loaded, yet it lifts a payload of 1,180 lb and has excellent short-field and slow-flying qualities.

A new Polish light aircraft is the S-4 Kania 2 (**12**), which first flew on September 12 at Mielec, and has since performed very well. Intended as a replacement for the CSS-13, the Kania 2 has a 125 h.p. M-11D engine and a speed range from 35 to 111 m.p.h., making it well suited to club duties (including parachuting and glider towing). The Czech Blanik sailplane (**8**) is well known—the "Cadillac of St. Yan"—but relatively new is the Herkules winch, now on test in Mk III form (**9**). Self-propelled, this has a kerosine-burning Tatra T-108 engine, rated at 134 h.p., consuming only about 0.084 Imp. gal per launch. Herkules III can take a high-performance sailplane to from 1,400 to 1,900ft in under one minute.

Finally, the little Czech HC-2 helicopter (**7**) is a two-seater, equipped with full navigation aids and instrumentation. Powered by an 80 h.p. Praga DH flat-four, the HC-2 can perform a wide range of duties. Gross weight is 1,279 lb, useful load 463 lb, main-rotor diameter 28.86ft and top speed 78 m.p.h.



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CORRESPONDENCE

The Editor of "Flight" is not necessarily in agreement with the views expressed by correspondents in these columns the names and addresses of the writers, not for publication in detail, must in all cases accompany letters.

Restrictions on the Private Pilot

WHILST I naturally sympathize with the views of my colleague in Jersey (Correspondence, November 29) regarding the necessity for strict observance of the regulations by all pilots, I feel that he has painted a somewhat misleading picture. Intentionally or otherwise he succeeds in conveying the impression that the attitude of a few irresponsible individuals is typical of the main body of private pilots in this country, and in this he does the latter less than justice.

In every group of pilots there are bound to be extremists, and as evidence of this I need only mention those airline pilots (some of whom I feel sure my Jersey colleague will have met) whose automatic reaction to the presence of a light aircraft within two or three miles, even in V.F.R. conditions, is one of entirely unnecessary alarm and disapproval.

The truth is, of course, that the vast majority of the private pilots of this country are fully aware of the importance and necessity of complying with the regulations governing air traffic, but at the same time they beg leave to doubt whether these regulations, as at present framed, are fair to their particular section of the flying community.

As an airline pilot who is also an enthusiastic private flyer I think I can claim with some justification to be able to see both sides of the question, and I have no hesitation in stating that on balance I feel that the private pilots' complaints are to a large extent justified.

To mention but one example. It is difficult to see what justification there can be for the choice of 1,500 feet as the overall lower level of the London Control Area, a height which still further restricts the already limited area in the South of England available to the private pilot for aerobatics. How often does commercial traffic need to fly at an altitude below, say, 3,000 feet, except in the immediate vicinity of the airports? Even if there are such occasions it is a matter for debate whether the commercial pilot should automatically receive priority over the private pilot. What an outcry there would be if bus drivers were given priority over private motorists on the open road!

What is needed surely is an impartial re-examination of the regulations by the appropriate authorities, bearing in mind the fact that they will not solve the admittedly complex problems of air traffic control on the airways by strangling the life out of private flying.

As a seafaring nation we have always guarded the freedom of the seas. Within reason let us also cherish the freedom of the air.

Teddington, Middx. PILOT.

LIKE your correspondent "Airline Pilot," I, too, have found the M.T.C.A. control staffs very helpful, but I find his "holier than thou" attitude to private pilots extremely nauseating.

If commercial licence holders are so punctilious in their observation of the Air Navigation Act, why do they ignore right of way rules when right is on the side of a light aircraft?

I do not believe that any flying instructor or private pilot is ignorant of the purpose of, and need for, Control Zones and Areas. The attitude which "Airline Pilot" described was undoubtedly a reaction to the continual circumscribing of the private pilot, which has been going on since the war. To give a few examples: An airway was routed over a glider site; Croydon was planned out of existence without (until recently and after tremendous agitation) consideration of the club, private and airline interests involved; and a glance at an air map of South-east England will show how little freedom of the skies is available to the private pilot who wishes to practice spinning and aerobatics, or fly into Croydon in any but near-perfect weather conditions.

Private non-radio aircraft are allowed into many of the main Continental airports—airline pilots have one routine, private pilots another, and peaceful coexistence is the result. In this country, the authorities take the line of least resistance, and that invariably means restriction of private aviation interests. If the private pilot is given consideration, he will return it. After all, today's private pilot is frequently tomorrow's commercial pilot.

Is not the positive approach to the problem of the one-eyed pilot to allow him to fly, subject to his wearing goggles? By the way, has "Airline Pilot" ever heard of Mr. Post? He flew to some purpose with only one eye, *and* no airways! (and I'll bet he made do without a "commercial," too).

Addington, Surrey. QFI

Tabloid or Tweenie?

IN his letter, "Tabloid or Tweenie" (*Flight*, November 29), Mr. Peter Brooks raises the interesting possibility that Spenser Grey might have used the Sopwith sociable two-seater No. 149 when he attacked Cologne on October 8, 1914. I am familiar with the illustration of this aircraft mentioned by Mr. Brooks, for I have the thirteen-volume work in which it appears.

For some long time past that same illustration has given me a great deal of thought, but it has always seemed to me that the caption was so obviously spurious that one could immediately discount any connection between the aircraft and Spenser Grey's gallant sortie against Cologne. Certainly the group of men appearing in the photograph seem to be French or Belgian, but there is no guarantee that the photograph was taken on October 8, 1914—nor, indeed, is it certain that it was taken at Antwerp. It must not be forgotten that photographs of Service aircraft in the field were extremely scarce in the early days of the war, and for propaganda purposes any suitable photograph—even though taken before the war started—was likely to be pressed into service over a topical caption.

But I should first like to make it clear that my acceptance of the official story of the raids of October 8, 1914, was by no means so unquestioning as Mr. Brooks seems to think. Let us consider the evidence. In *Fights and Flights*, page 97, Cdr. C. R. Samson (who was at Antwerp until October 7, 1914) stated:—

> "Certain aeroplanes were to be left to the last in order to carry out an attack on the Zeppelin sheds at Düsseldorf and Cologne. Spencer-Grey (*sic*) and Marix, with two Sopwith Tabloids, were detailed for this."

And again, on page 107:—

> "The weather was too misty for a start to be made until 1.30 p.m. on October 9th (*sic*), at which time Spencer-Grey and Marix set off in their 'Tabloids.'"

In Vol. I of *The War in the Air*, page 389, we find Sir Walter Raleigh's statement:—

> "On the forenoon of the 8th the weather was misty, so Squadron Commander Spenser Grey and Flight Lieutenant Marix spent the time in tuning up their Sopwith Tabloid machines."

And lastly there is the evidence of Commodore Murray F. Sueter's letter to the Sopwith company, dated December 28, 1914, and reproduced in *Jane's* 1919 edition on page 167a:—

> "AD5062.
> Gentlemen,
> With reference to the recent attack on the German Airsheds at Cologne and Düsseldorf, carried out by Squadron Commander Spenser D. A. Grey and Flight Lieut. R. L. G. Marix, you may be interested to learn that the machines used were your 'Sopwith Tabloid aeroplanes.' I take the opportunity of expressing my appreciation of the excellent performance of these machines."

It seemed (and still seems) to me that there could be little doubt about the identity of Spenser Grey's aircraft.

But the problem of No. 149 remains. It is unquestionably the aircraft depicted in the illustration in *The Great War*, and I should greatly like to know precisely when and where the original photograph was taken—and whether the British Naval officer in it was in fact Spenser Grey.

Early in 1914, the Sopwith sociable two-seater (No. 149) was described as an 80 h.p. biplane, thus indicating that the power unit was (originally at least) an 80 h.p. Gnôme, not a 100 h.p. Gnôme Monosoupape. It is quite certain that No. 149 was crashed at Eastchurch on March 25, 1914, by Spenser Grey, with Gerald Aldwell as his passenger, and contemporary reports indicate that the aircraft was extensively damaged. I do not know of any record which positively states that the machine was written off, but if it was rebuilt the rebuilding must have been extensive. It is not without significance that the aeroplane illustrated in *The Great War* has a greater gap than the original No. 149, two windscreens have replaced the raised cockpit edge, the nose appears to have been shortened, and a fin has been added.

On page 5 of *Fights and Flights* Samson listed the aircraft which he took to war on August 27, 1914, and among them were ". . . two Sopwith biplanes, fitted with an 80 h.p. Gnôme engine." There is a well-known photograph of the aircraft of Samson's squadron, believed to have been taken early in the war, which clearly shows the B.E.2a No. 50, the Short biplane No. 42, and an 80 h.p. Sopwith biplane of the 1913 three-seater type. Samson goes on to indicate that both of his 80 h.p. Sopwiths were of the same type, which, if his record is accurate, excludes the Tweenie as a possible machine of his unit at that time. Writing of September 17, 1914, he said:—

> "The aeroplanes at Antwerp now consisted of two B.E. biplanes

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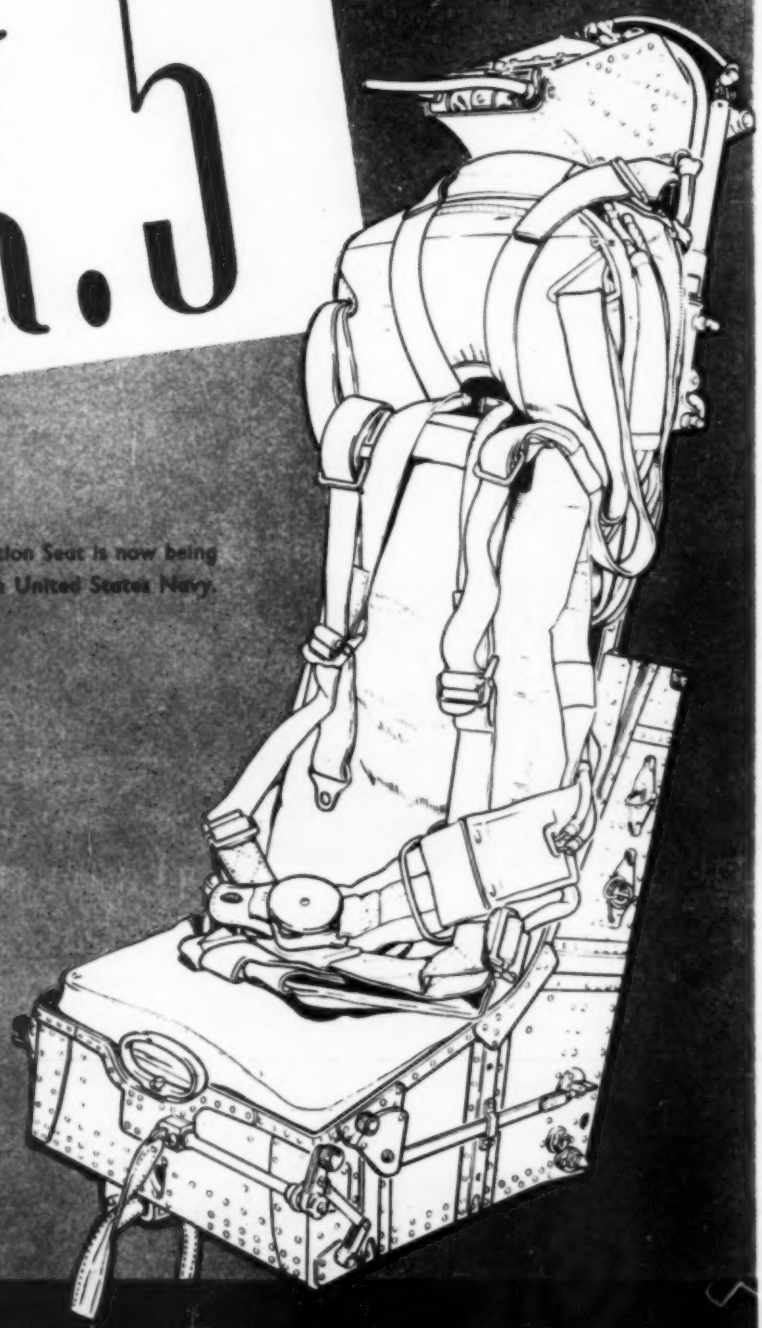
Mk.5

The Martin-Baker Mk.5 Ejection Seat is now being delivered in quantity to the United States Navy.



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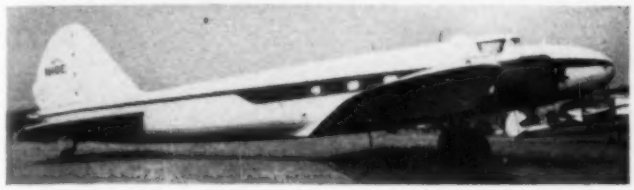

Three conversions for executive duties (see letter from Denis M. Powell): upper left, modified Douglas B-23 Dragon owned by Standard Oil; lower, 1935 Boeing 247D (N.18E, ex-NC.13340 of U.A.L.), owned by Richard Uricho, Jnr.; above, a smart Lockheed Vega, N.13705, owner unknown.

CORRESPONDENCE . . .

and one 80 h.p. Sopwith biplane; two Sopwith Tabloids were daily expected to arrive from England."

What, then, does one assume that last-mentioned 80 h.p. Sopwith to have been? However, Samson later records:—

"On September 22 the long-expected attack was made on the Zeppelin sheds. Four aeroplanes started out from Antwerp, flown by Major Gerrard, Lieutenant Collet, Lieutenant Marix and Lieutenant Spenser Grey (*sic*), the latter carrying Lieutenant Newton Clare as passenger."

Readers may place whatever construction they wish upon the statements that a fourth aeroplane participated and that Spenser Grey carried a passenger. It would be possible to connect them and to add the photograph of the modified Tweenie for good measure. The fact that that is a form of guesswork which I personally dislike does not diminish the possibility that it may be correct; but, lacking absolute confirmation that the Tweenie was still in use after the outbreak of war, I have always hesitated to call it a war-time type. (Doubtless the fourth machine was merely borrowed from the Dunkerque Flight of Samson's unit—the Antwerp Flight was specifically intended to bomb the airship sheds.)

I shall be very surprised if proof can be found that production of the Sopwith Sociable, or Tweenie, was undertaken. I think that the production aircraft which Mr. Brooks has in mind must have been the "Spinning Jenny" two-seaters: two dozen were built, powered by the 100 h.p. Monosoupape, but the Spinning Jenny was a tandem two-seater. Its span, however, was 36ft—exactly the value quoted by Mr. Brooks.

Birmingham, 32. J. M. BRUCE.

Veteran Executive Aircraft

CONGRATULATIONS to *Flight* on its really excellent enlarged "special" (October 11) containing a comprehensive review on the leading European and North American types of business/executive transports.

Regarding the section devoted to the leading U.S.A. types (pages 586-595), it is perhaps logical that the world's richest country today produces the world's biggest selection of aeroplanes in these categories. Nevertheless, the most remarkable thing about business/executive/private flying in America nowadays is the relatively large numbers of World War 2 (and even a substantial number of pre-1939) types in service; and this in spite of the relatively expensive conversion and operating costs compared with the highly efficient and more economic aeroplanes of these categories (except the DC-3!) produced in the past five to ten years.

On page 595 you briefly describe certain classes of conversions on the C-47/DC-3, Lodestar, Ventura, and Douglas Invader by the well-known Wold organization. I would suggest that these four types represent less than half of the impressive total of former bomber/transports of the 1939-45 war which have survived and which, following some of the most amazing conversion jobs by several highly enterprising specialist firms, are giving fast, reliable and all-round excellent service to their current owners.

For example, on the current American civil register, and flying as executive transports, are eight Douglas A-20 Bostons, 44 Douglas B-26 Invaders, 14 Douglas B-18 Digbys (U.S.A.F. name Bolos) plus 19 Douglas B-23 Dragons. Of 162 Curtiss C-46 Commandos currently flying in the U.S., three are furnished as luxurious "flying offices" for presidents and vice-presidents of their owners. At least one Convair PBY-5A Catalina is fitted out as a super-luxury "flying yacht," and I believe this particular Catalina transitted Prestwick Airport early this year. There are 11 North American B-25 Mitchells, including Mr. Paul Mantz's celebrated and extremely colourful "Cinemascope flying laboratory" (which visited Nairobi recently with the president of 20th-Century Fox aboard). Martin Aircraft are represented by six B-26 Marauders with an equal number of M-202s disposed of several years ago by Northwest Airlines.

Among the less-publicized amphibians nowadays, there are considerable numbers of Grumman G-21s, G-44s and G-73s; and there are at least 50 of the G-73 Mallards, last of the line in this manufacturer's notable achievements in this field. A strange Grumman Avenger conversion is one of the type fitted with a cabin to take four passengers! Even more remarkable are about 40 French-built G-44 Widgeons imported from France last year, about half of which are now flying the U.S., having been re-built to U.S. standards, including the fitting of Lycoming 270 h.p. or Continental 220 h.p. powerplants. Other amphibians include 650 Republic Seabees still active, and finally half-a-dozen old-time Sikorskys (three S-39s and three S-43s) still going strong after more than two decades!

Surviving veterans of the 1932-39 era include six Lockheed Vegas and one Lockheed Orion, plus several Model 10s and 12s Electras, eight Boeing 247Ds, one B-307 Stratoliner, two DC-2s, 14 Luscombe Phantoms and 28 Noorduyn Norsemen, plus the huge total of 768 Waco biplanes (all models), about a third of which possess current C.s of A. This list, I may add, is far from complete.

In closing, perhaps I may remark that *Flight's* "specials" published on regular occasions every year provide regular readers (and irregular ones, too) with most valuable records of information on the many specialized subjects they cover in world aviation, both civil and military. I subscribe to several of the foreign aviation journals; but I must say that, whilst *Flight* may *sometimes* be equalled, it is certainly never surpassed.

Nairobi, East Africa. DENNIS M. POWELL.

ICBM a Misnomer?

THE term "intercontinental ballistic missile" is frequently used to describe the latest rockets. Can any reader explain the relevancy of the word ballistic? Surely all missiles obey the laws of ballistics. The word missile is ill-chosen, too, for whilst all rockets (when their fuel is expended) are missiles, all missiles are not necessarily rockets. As for intercontinental, this may mean any distance between a few feet and 12,000 miles.

What is wrong with "long-range rocket" which explains exactly what it is?

London, W.14. M. A. SANDYS.

[If a missile has wings it need not follow a ballistic trajectory. The word "missile" is preferable to "rocket," because the winged, non-ballistic, intercontinental weapons are not rocket propelled. Examples of these are the SM-62 Snark and the SM-64 Navaho. Intercontinental range is defined as 4,000 to 5,500 miles.—Ed.]

FORTHCOMING EVENTS

Dec. 31. Kronfeld Club: New Year's Party.
Jan. 1. Kronfeld Club: "Radio Observation of Russian Satellites," by G. Whitfield.
Jan. 2. R.Ae.S.: Young People's Lecture, by A. W. Bedford, A.F.C., A.R.Ae.S.
Jan. 4. British Interplanetary Society: "High Altitude Research During the International Geophysical Year," by Dr. R. F. L. Boyd.
Jan. 8. Kronfeld Club: "On the Yorkshire Gliding Club," with films by J. C. Riddell.
Jan. 10. Helicopter Association: "Boost Systems for Helicopter Gas Turbines," by A. W. Morley, Ph.D., A.F.R.Ae.S.
Jan. 15. R.Ae.S.: Main Lecture at Leicester: "Rolls-Royce Engines," by A. A. Lombard, F.R.Ae.S.

R.Ae.S. Lectures (to Jan. 15):—
Jan. 7, *London Airport*, "Airline Operational Flying," by Capt. W. Baillie. Jan. 8, *Bristol*, "Fail Safe Structures," by N. F. Harpur; *Southampton*, Annual General Meeting and Film Show; *Weybridge*, Rrains Trust. Jan. 14, *Boscombe Down*, "Aircraft Control," by Prof. G. A. Whitfield; *Cambridge*, Lecture by W/C. Lewis. Jan. 15, *Leicester*, Main Lecture (see above).

Work continues around the clock on the Boeing 707—still scheduled to fly before the end of the year. Lights in the windows of the first production aircraft give a seasonal touch to the flight line at Renton.

CIVIL AVIATION

REPUBLIC'S NEW RAINBOW

IT is reported from the United States that Republic Aviation Corporation are testing airline reaction to a new short/medium-range turboprop—their first civil transport venture, apart from the earlier Rainbow, since the company's name was changed from Seversky in 1939.

The new turboprop is to perpetuate the name Rainbow, which was given to the commercial version of the XR-12 long-range photo-reconnaissance aircraft which was flown in 1946. A special feature will be large slotted Fowler flaps and leading-edge slats to give a good short-field performance. Republic are proposing to use either four General Electric T64s or four Rolls-Royce Dart RDa.10s of 2,655 e.s.h.p. The Rolls-Royce-powered version would have a take-off weight of 77,500 lb and would be 1,500 lb heavier than the alternative version.

Some idea of the importance which is attached to interior decor may be gathered from the early announcement that the cabin colour scheme would be designed by Charles Butler Associates. Two seating versions are being offered; a first-class configuration with 68 seats placed five-abreast and an 80-seat tourist version with at least some of the seats six-abreast. Other details that have been given are: span, 111ft 11in; length 87ft; height, 29ft 6in; cruising speed, over 400 m.p.h.; average range, 2,200 miles; and cruising altitude, 25,000ft. The estimated take-off run at gross weight is said to be about 3,000ft, and the landing run 4,000ft at sea level on a standard day.

TRANSATLANTIC TIMETABLES

DISPARITY between B.O.A.C. and El Al schedules for operating the same aircraft on the same route has aroused a spate of criticism. The Corporation has been accused of over-caution and lack of enterprise. Although such criticism may be damaging, the British line has limited its reply to the observation that, at any rate initially, they consider their timetable to be realistic. The schedules were published on p. 970 in last week's issue.

Israeli aircraft will follow courses suggested by prevailing North Atlantic pressure-patterns. This is no new technique over the North Atlantic, but the higher cruising altitude of the Britannia enables it to be used to greater effect. Precise meteorological knowledge of these altitudes is still limited, and it will be some time before timetables based on pressure-pattern flight planning will cease to contain a degree of uncertainty. El Al has set a timetable which is admitted to be possible only on four occasions out of five.

B.O.A.C.'s experience is that punctuality with new aircraft types can be obtained only by flexible scheduling and that only experience can prove the realism of a timetable.

An account of a transatlantic Britannia flight, and an examination of flight-planning techniques, will be presented in an early issue of *Flight*.

CONCRETE AID REQUIRED

THE significance of the position occupied by Ceylon on the air route map of the world is growing as the range of modern airliners increases; for the most direct route between Europe and S.E. Asia (and on to Australia) lies through Ceylon. Until recently aircraft range with full payload has usually been such that airliners were routed *via* Calcutta to avoid the 1,700-mile overwater crossing between Colombo and Singapore. But transports designed to fly regular non-stop North Atlantic services will seek the most direct routes available.

Ceylon's Minister of Transport, Mr. Senanayake, is asking Parliament to approve expenditure of Rs.475,000 (£36,000) without which "Ratmalana airport may have to be closed down in the near future," because the runway is "now crumbling rapidly." The next step will be to find nearly £4m to finance construction of an airport suitable for accommodating turbojet airliners: hopeful eyes are looking towards Washington.

THE INDIAN AIRLINER MARKET

DESPITE India's foreign-exchange problems and difficulties in finding money to finance the second Five-Year Plan, the Indian market for both civil and military short-haul transport aircraft continues to attract the attention of European manufacturers.

Between now and early January the Fokker Friendship will be demonstrated to Indian airlines and aviation authorities. The nationalized carrier, Indian Airlines Corporation, operating an ageing fleet (including 64 DC-3s and 12 Vikings), is the principal target for Fokker salesmen, although the trend towards greater scope for independent airlines means that potential customers are to be found among companies such as Air Assam, Dharbhanga Aviation, Indamer, Jamair and Kalinga. A strong selling point is the possibility that Hindustan Aircraft, Ltd., might manufacture the Friendship under licence at Bangalore.

The departure of the Friendship to continue demonstrations in the Middle East will almost coincide with the arrival in India of representatives from Handley Page, intent on selling the Dart-powered Herald.

But British and Dutch salesmen will find that they are not the first in this field. Since mid-November a French Nord 2508 (combination freight/passenger version of the military Noratlas) has

An impression of American Airlines' new £5m terminal at Idlewild, due to be completed in 1959. Extensible passenger corridors swing clear to allow the aircraft to taxi under their own power up to the departure lounge.

The Noratlas 2508 which Kalinga Airways, the Indian airline, are operating experimentally from Calcutta. It has Double Wasp engines and wing-tip jets.

been operating a series of experimental flights under the colours of Kalinga Airways. Reports from Calcutta state that this airline has now purchased six of these aircraft and four Breguet Deux Ponts. Kalinga has recently been granted, by the Indian Government, a six-year licence to operate a scheduled service between Calcutta and Lhasa, and is now awaiting similar permission from the Chinese authorities.

TWIN PIONEERS GROUNDED

A SEQUEL to the tragic accident to the Twin Pioneer in the Libyan desert, in which Mr. D. F. McIntyre, Mr. Roy Smith and four other members of the crew were killed, has been the grounding of aircraft of this type. Cables have gone to Australia, Austria, Mexico, Persia and Borneo—all places where Twin Pioneers are operating—announcing the decision.

A statement made after the accident by Mr. T. D. M. Robertson, director and general manager of Scottish Aviation, said that the manufacturer's party that went to the scene of the accident in Libya returned to Prestwick on Saturday, December 14. Parts of the wrecked aircraft, which they brought back, were sent immediately to Farnborough for examination. "As a special precaution, it has been decided to suspend all flying operations until technical experts from the company and R.A.E. Farnborough have had time to consider the reports which have been handed to them. It is expected that the suspension of flying will not last more than a few days."

Mr. Robertson added: "The finest memorial that could be erected to the memory of Mr. D. F. McIntyre would be to establish Twin Pioneers on the map of world aviation. That will be the aim of the directors."

PRESTWICK'S RUNWAYS

ALTHOUGH reconstruction work on the runways at Prestwick is taking place, there are fears that the main runway will not at this stage be increased to a length suitable for the DC-8. Present work is aimed merely at making the main runway long enough for Britannia services through Prestwick; it is being increased in length by 500ft and strengthened in bearing.

Financial sanction has so far been given only for an extension to 7,500ft with 500ft of stopway at either end. This is well below the 9,050ft which T.C.A.—the first airline to give clear notice of its intention to use jets through Prestwick—has estimated as a minimum requirement, although a survey has been made by the M.T.C.A. with the ultimate object of providing a paved length of about 9,500ft, the maximum which can reasonably be accommodated.

Visits to Scotland by the Canadian trade mission to the United Kingdom, and a letter to the Scottish Council for Development and Industry from Mr. G. R. McGregor, president of T.C.A., have resulted in increased demands for additional concrete. Mr. McGregor was replying to the Scottish Council, who had been informed that the Government had no official information that the airline wanted to use the airport for DC-8s. He said that T.C.A. intend to provide four return flights a week from Prestwick, one to Toronto and three to Montreal; an intention that had been intimated to I.A.T.A. in December 1956.

An award of £200 was recently made to Mr. L. Sayer (right), technical training superintendent of the flight operations branch of B.E.A., for his suggestion regarding route training equipment. The award was presented by Capt. J. W. G. James, flight operations director, and is the highest made during the current year.

THE HAZARDS OF FORECASTING

FOLLOWING on the heels of Prof. Brewer's freight forecast for the Boeing Airplane Company comes the latest research paper prepared by the Institut du Transport Aerien (*No. 307: Forecast of the Development of Europe's Exports by Air to North America*). The indefatigable M. Pierre Bouquet has been conducting a "long and difficult" survey of the European export market and has gathered a rich harvest of statistics (much of which has had to be "handled with circumspection").

The results of this survey have been presented in seven research papers. The first five studied each of the main categories of freight in detail, the sixth paper was a summary of the previous five, and the latest paper concentrates on freight moving from Europe to North America.

M. Bouquet's survey is based on the assumption that goods can bear an average transportation charge equivalent to ten per cent of its value. On this basis it is possible, from Customs returns, to calculate the potential volumes of specific commodities which will move at specific freight rates. In this way the I.T.A. have constructed highly detailed tables of figures and attractive graphs showing freight trends for each commodity or country.

The validity of the basic assumption—ability to pay ten per cent on transport—can surely be questioned. This is a generally accepted average for all freight; but it is certain that many commodities are prepared to pay a premium over the ten per cent average in return for greater speed. Cut flowers and sea-food are two examples of this wide range of goods.

Prof. Brewer attempted to overcome this problem by basing his calculation on the assumption that potential air freight is represented by the "cream" of actual surface freight. He has estimated the volume of freight which will be moving by truck and train at various freight rates. As air freight rates drop down to these surface rates, so do the commodities moving by surface transport become potential air freight.

Prof. Brewer's method is probably more realistic than that employed by M. Bouquet. This is no belittlement of the I.T.A. Not only would the research costs of conducting such a survey of surface freight in Europe be prohibitive, but the lack of reliable basic data would probably render such a survey futile.

But both methods suffer a common weakness. Neither takes account of goods which are not being exported because the right combination of low rate and rapid transit is not yet available. A more fundamental criticism of forecasting potential freight volume is whether such forecasts serve a practical purpose. How realistic is it to consider the effects of 50 per cent rate cuts at a time when rates are being increased by five per cent?

The most useful feature of these surveys is the courageous gathering of inaccessible and scattered information, and its presentation in an intelligent and coherent fashion.

Interior of the Vertol 44B, with 15 seats ranged along the starboard side. New York Airways interest is reported in the accompanying paragraph. This helicopter was described in "Flight" on May 10, 1957.

CIVIL AVIATION . . .

VERTOLS FOR NEW YORK AIRWAYS?

NEW York's helicopter airline, New York Airways, have announced that they are giving serious consideration to the purchase of a fleet of Vertol 44Bs to replace their entire fleet of Sikorsky S-58s and S-55s. Negotiations for the transfer of the three S-58s and five S-55s to another operator are already in hand, and if the purchase of the twin-rotor Vertols is completed, they should be in use in the late spring of next year. The helicopters would be equipped with flotation gear (standard on all the airline's fleet) and the suffix B denotes that the interior would be furnished in the 15-seat arrangement shown above. According to N.Y.A.'s president, Mr. Robert L. Cummings, Jnr., "studies of operating and maintenance costs are rapidly approaching conclusion and so far indicate that this re-equipment programme can become a reality in the near future. New York Airways has always considered that one of its primary objectives is to be of maximum assistance in the expeditious development of the helicopter as a transport vehicle." (Considerable interest has been expressed in the Rotodyne.)

Since starting operations in October 1952, N.Y.A. had, by October 1 this year, flown 1,850,867 scheduled miles, and carried 129,867 passengers, 10,125,543 lb of mail, 1,975,474 lb freight and 4,684,393 lb of air express. The Vertol 44B appears to offer better facilities for mixed passenger/freight loads than is available with the present fleet; the cabin is 20ft long, and the seats can be quickly folded against the bulkhead or removed entirely.

NEW ROAD-AIR CARGO SERVICE

THE British independent airline Silver City announces a new low-rate cargo service between London and Paris. It is in addition to their existing Roadair system. Cargo, delivered to the Silver City freight depot in Chelsea, is taken by road to Ferryfield, flown to Le Touquet by Bristol Freighters, and transferred by road again to Paris. The cost of a shipment weighing 1,000 lb is about £11; rates for small consignments range from 5d per lb for packages of up to 25 lb. There are reductions for journeys originating at the airport.

BREVITIES

QUEEN ELIZABETH the Queen Mother will travel in a B.O.A.C. DC-7C when she leaves on January 28 on her visit to Australia and New Zealand *via* Montreal, Vancouver, Honolulu and Fiji. On Her Majesty's return journey to the United Kingdom she will officially open Nairobi's new airport at Embakasi on March 8. Work on this airport began in 1954 and will not be completed until later in 1958.

* * *

Some B.E.A. pilots are being taught Russian in readiness for the introduction of services between London and Moscow.

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Lufthansa will include Porto Alegre on their service to Buenos Aires from January 4.

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A Britannia 302, operated by Aeronaves de Mexico, with 90 passengers, recently covered the 2,100 miles between Mexico City and New York in the record time of 5hr 34 min.

* * *

Sabena is seeking government approval to finance purchase of aircraft by an increase in capital from B.Frs.500m (£3.6m) to B.Frs.1,000m (£7.1m).

* * *

The Indian Minister for Civil Aviation recently announced that his government has received a proposal to operate a once-weekly service with jet aircraft between Moscow and Delhi.

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It is reported by an American source that Trans-Australia Airlines will decide very shortly whether or not to exercise its option on two Caravelles for delivery in mid-1960.

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International Aeradio has recently concluded a three-year technical and operational contract for the secondment of seven specialist aviation officers for the operation of Kuwait airport.

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Avianca, the Colombian airline, celebrated its thirty-eighth anniversary this month. It carried a record of 76,000 tons of cargo last year.

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The Bristol Aircraft, Ltd., indicate that results of latest Britannia icing tests are "encouraging" and that "modifications so tested have performed well in the extremely arduous weather conditions successfully found."

* * *

East African Airways have recently introduced a new service linking Nairobi and the Serengeti National Park in Tanganyika. The inclusive cost of air and road travel, together with meals, refreshments and eight hours in the Park, is E.A.Sh.120 per head.

* * *

Informal discussions in Washington, following a conference last month between the C.A.A. and A.R.B., have recently been concluded. It is reported that there are now good prospects of bringing each country's turbine transport requirements substantially into line. A further meeting is to be held, probably early next summer.

A B.O.A.C. DC-7C, assisted by tailwinds up to 155 knots, flew from Montreal to London in 8 hr 20 min earlier this month.

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A broadcast on Moscow radio recently stated that Soviet internal air fares are almost 15 per cent lower than rail fares. Between some points more passengers travel by aircraft than by train.

* * *

Air Ceylon has just completed its first decade. In this time it has logged eight million aircraft miles without a single passenger sustaining even a minor injury.

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Officials of Panair do Brasil have explained that their choice of the DC-8 in preference to the B-707 was determined by payload limitations of the Boeing aircraft on the overwater sector between Rio de Janeiro and Lisbon.

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Conversion of REAL's CV-340s to Eland turboprop power—in order to compete with V.A.S.P.'s Viscounts—will depend on U.S. certification for the conversion being obtained next spring.

* * *

A new company, Indian Airlines Association, has been formed to operate domestic services previously flown by Indian Airlines Corporation within Nepal. The Government of Nepal, Kalinga Airways and I.A.C. are associated in the new company.

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No further announcements have been made concerning the operation of regular scheduled services to replace those carried out in the past by K.L.M. There is a possibility that S.A.S. will operate a once-weekly service from Stockholm to Jakarta.

The newly appointed Canadian High Commissioner in London, the Hon. George A. Drew (left) is seen with Rear Admiral Sir Matthew S. Slattery, chairman of Shorts, inspecting a Comet spar assembly during a recent visit to the main factory at Belfast.

Club and Gliding News

"AIRFLOW Over Mountains; Notes for Forecasters and Pilots" is the title of a Meteorological Office report by G. A. Corby, B.Sc., which contains much of interest to pilots of sailplanes and powered aircraft. The report is divided into four parts. A brief survey is first given of the observational evidence of special airflow effects near mountains, as provided by the visual evidence of clouds and the experiences of pilots. Secondly, theoretical work on the subject is discussed, and this in turn is applied to aviation forecasting. The final section concerns additional information for pilots and deals in turn with what to expect; action to be taken in flight over hills; aircraft icing over mountains; and upper winds.

Tandem Tutor flies high: Elevated from circuit-bashing to wave-flying at 5,000 ft over Camphill this summer was this T.31 of Derby and Lancs. Gliding Club, flown by Phil Leach and Paul Newmark.

A new R.A.F.G.S.A. club at Leeming commenced operations recently (see news item below). Here G/C. J. M. Thompson, the station commander, briefs Boy Entrant Fieldhouse prior to a flight in a Cadet Mk2.

OUT-OF-THE-ORDINARY subject of a talk at the Kronfeld Club, London, on December 11 was *The Probability of Intelligent Life Evolving on a Planet*. This was given by Dr. A. E. Slater and was based on his paper presented at the recent astronautical conference in Barcelona. After reviewing the highly improbable line of evolution of Homo Sapiens on Earth over the past 500 million years, Dr. Slater's conclusion was that a similar development on any other planet was not probable. The Kronfeld Club's Christmas Party, a characteristically lively and enjoyable affair, was held the following Wednesday, December 18.

APPROVED night cross-country route for Fair Oaks Aero Club members aiming at the Commercial Pilot's Licence is Fair Oaks/Blackbushe/Hurn and return, with landings made at Hurn. The first flights on this route were made last month, and the first solo night cross-country was logged by Mrs. Yvonne Pope. To round off the festive season at Fair Oaks, the club is organizing a New Year's Eve party.

DETAILS of the aircraft to be flown by British pilots in next year's World Gliding Championships (Leszno, Poland, June 15-29) have been given by the British Gliding Association. Nicholas Goodhart will fly either a modified Skylark 3 (with improved outer wing panels) or a new version of the Olympia 403; and Tony Deane-Drummond will fly the new version of the Olympia 403. Philip Wills and Tony Goodhart will each fly a "limited class" sailplane, one a 15-metre version of the Olympia similar to the 401, and the other either a Skylark 2 or another Olympia 401.

NATIONAL competition gliding in this country next year will take the form of decentralized contests during a National Soaring Week from July 26 to August 4. It is hoped that contest flying will take place at five widely separated club sites; there will be no national gliding championships as such, however, and the title of national champion will not be awarded. There will be no handicapping in the soaring-week contests, and all competitors at each site will fly the same tasks. It is the B.G.A. intention that National Gliding Championships should be held every two years.

MOST recently formed member-club of the R.A.F. Gliding and Soaring Association is that of R.A.F. station Leeming, Yorkshire. F/L. E. W. Clarke, a flying instructor on the station, is primarily responsible for the formation of the club, which at present has approximately 50 members. Launching of the club's two gliders is by auto-tow.

PREPARATIONS for the Scottish Aero Club's Hogmanay dinner-dance, at which a record attendance is expected, should be almost complete by the time this issue appears. The club's monthly flying-hours total continues to show an increase over last year's figures.

PORTABLE MOBILITY FOR LIGHT-AIRCRAFT PILOTS

Designed primarily for pilots of light aircraft needing a convenient form of aerodrome - to - town transport which can be carried in the rear of a small cockpit, the collapsible scooter here illustrated—the Airscooter—is now in production. It has been developed by Airscooters, Ltd., 93 Regent Street, London, W.1, and is powered by a 50 c.c. two-stroke engine. The machine weighs 70 lb, and comprises four detachable parts which can be assembled (by means of three wing-nuts) within the space of 1½ minutes.

Air Marshal Sir Douglas Macfadyen, A.O.C-in-C. Home Command (right), presenting the Hack Trophy to W/C. N. Cameron, C.O. of London University Air Squadron, at Senate House on December 6. W/C. E. J. Hack, donor of the trophy, and Dr. J. F. Lockwood, Vice-Chancellor, are in the centre of the group.

SERVICE AVIATION

Royal Air Forces and Naval Flying News

Senior Appointments

THREE senior R.A.F. appointments have been announced by Air Ministry. A.V-M. G. L. Worthington is to be Director-General of Equipment at Air Ministry from March 14 next year; A. Cdre E. N. Lowe is to be A.O.C. No. 40 Group, Maintenance Command, from February 24 next year with the acting rank of air vice-marshal; and A. Cdre. R. W. L. Glenn is to be Director-General of Personal Services at Air Ministry from next February, also with the acting rank of air vice-marshal.

A.V-M. Worthington has been with Maintenance Command for the past four years, first as A.O.C. No. 42 Group and then since August 1955 as A.O.C. No. 40 Group. An equipment specialist since 1926, one of his wartime appointments was as deputy A.O.A. at H.Q., Allied Expeditionary Air Forces. A. Cdre. Lowe has been S.A.S.O. at No. 41 Group, Maintenance Command, since August last year and was formerly Deputy Assistant Chief of Staff (Logistics) at SHAPE. A. Cdre. Glenn has been A.O.C., R.A.F. Record Office, Gloucester, since March last year and before that was for nearly three years Director of Postings (B) at Air Ministry.

Baghdad Pact Appointment

S.A.S.O. at A.H.Q. Levant for the past year, and before that C.O. of R.A.F. Kirton-in-Lindsey for nearly three years, A. Cdre. W. S. Gardner has been appointed Director of Plans (Operations and Training) of the Baghdad Pact Organization in Baghdad.

At the outbreak of the Second World War A. Cdre. Gardner was on the staff of No. 5 (Bomber) Group and from June 1940 to November 1941 was on operational flying duties with Nos. 106, 44 and 144 Sqns., being awarded the D.F.C. in 1940 and a Bar to it in 1941. In June 1943 he was awarded the A.F.C. and in January 1945 made O.B.E. He was also three times mentioned in despatches during the war. Immediately prior to going to Kirton-in-Lindsey he was on the Air Staff at H.Q. Home Command, and before that he had served in Northern Ireland and the Middle East.

A.F.C. Award

AN A.F.C. has been awarded to F/L. J. F. W. Pembridge for his skill and courage on October 3 in saving the lives of his crew and preventing a burning aircraft from falling into a built-up area.

F/L. Pembridge, at that time with No. 139 (Jamaica) Squadron, was captain of a Canberra B.6 when fire broke out in the port wing soon after take-off with a full fuel-load. He shut down the port engine, initiated emergency drills and informed control. The fire appeared to die down but it had severed both port aileron controls and burnt a large hole in the wing; F/L. Pembridge found that lateral control could not be maintained below 190 kt and as the aircraft reached base the fire broke out again more intensely. He gave the order to abandon aircraft and the navigator ejected; but when the observer found difficulty in leaving, F/L. Pembridge succeeded in clearing his harness from an obstruction, reduced speed to the minimum at which he could control the aircraft and then pushed the observer out. As he was by then too low to bale out himself, F/L. Pembridge manœuvred the Canberra in line with the runway and made a successful crash-landing at high speed.

The official citation in the *London Gazette* says that "by his calm, self-discipline and a complete disregard for personal safety F/L. Pembridge saved his observer's life, prevented a burning aircraft from crashing into a built-up area and preserved it for subsequent investigation. He showed skill of the highest order."

Field Marshal Sir William Slim, Governor-General of Australia, hands the Sword of Honour to A. Cdt. U/Off. R. D. Crump at the graduation parade of No. 7 Course at the R.A.A.F. College, Point Cook, on December 11. Just visible behind is the College Commandant, G/C. D. W. Colquhoun.

F/L. Pembridge, who joined the R.A.F. in 1941, is at present on a course at No. 230 Vulcan O.C.U. at R.A.F. Waddington, and after qualifying as a captain on these aircraft is to join the unit as a flying instructor.

Lady Cade Medal

FOR his work in developing the casualty evacuation rôle of Beverleys and Comets and thus improving air evacuation and the comfort of patients, S/L. E. J. McGuire has been awarded the Lady Cade Medal for 1957. This is given annually to an officer of the R.A.F. Medical Branch who has done outstanding work. S/L. McGuire has been S.M.O. at R.A.F. Lyneham since 1955. His casualty evacuation work has also brought about a revision in the equipment and drugs carried in flight sisters' medical kits and a modification of harness and stretcher gear.

Parachute Medical Team

FORMED recently and based at R.A.F. Akrotiri in Cyprus, the ten-man M.E.A.F. Parachute Medical Team is ready to go to the aid of air crash survivors in the eastern Mediterranean region whenever such an emergency should arise.

Led by F/L. G. E. Collins, a parachute instructor with over 88 descents to his credit, the team consists of volunteers who train constantly in their own time. F/L. Collins checks harnesses in the air and briefs the pilot on the D.Z., then makes the first jump and places markers, directing the other members' descents by loud-hailer.

Sgt. P. Donley, who has made 88 jumps, is in charge of the team in the air and second-in-command to F/L. Collins; and F/L. R. F. Reynolds takes charge on the ground when the 16-bed hospital (contained in special packs) and the team are in position. Its other members are Sgt. J. Mooring, Cpls. P. Greenfield, D. Merrick, W. Dyer and M. Kennedy, S.A/C. D. Dean and L.A/C. P. O'Neill.

The team's specially adapted aircraft is

based at Nicosia; in an emergency, while it flew the short distance to Akrotiri each man would leave his work and put on parachute harness with a five-foot-long pack weighing 60 lb. Tentage and heavier equipment is coupled to freight parachutes ready to be thrown from the aircraft.

Air Corps Colonel

IT was announced recently by the War Office that General Sir Hugh Stockwell (Colonel, Royal Welch Fusiliers and Malay Regiment) has been appointed Colonel Commandant, Army Air Corps.

Photographic Memento

A UNIQUE set of photographs depicting some of its earliest aerial activities during the last war is to be presented to No. 4 Squadron by one of its former members, F/L. D. A. Drewitt. He took them when flying as observer and air gunner in one of the squadron's Lysanders during the German advance into Belgium in May 1940. F/L. Drewitt, who was then an L. A/C. and later won the D.F.M., is at H.Q. 2nd T.A.F.; No. 4 Sqn is now based at Jever and equipped with Hunters.

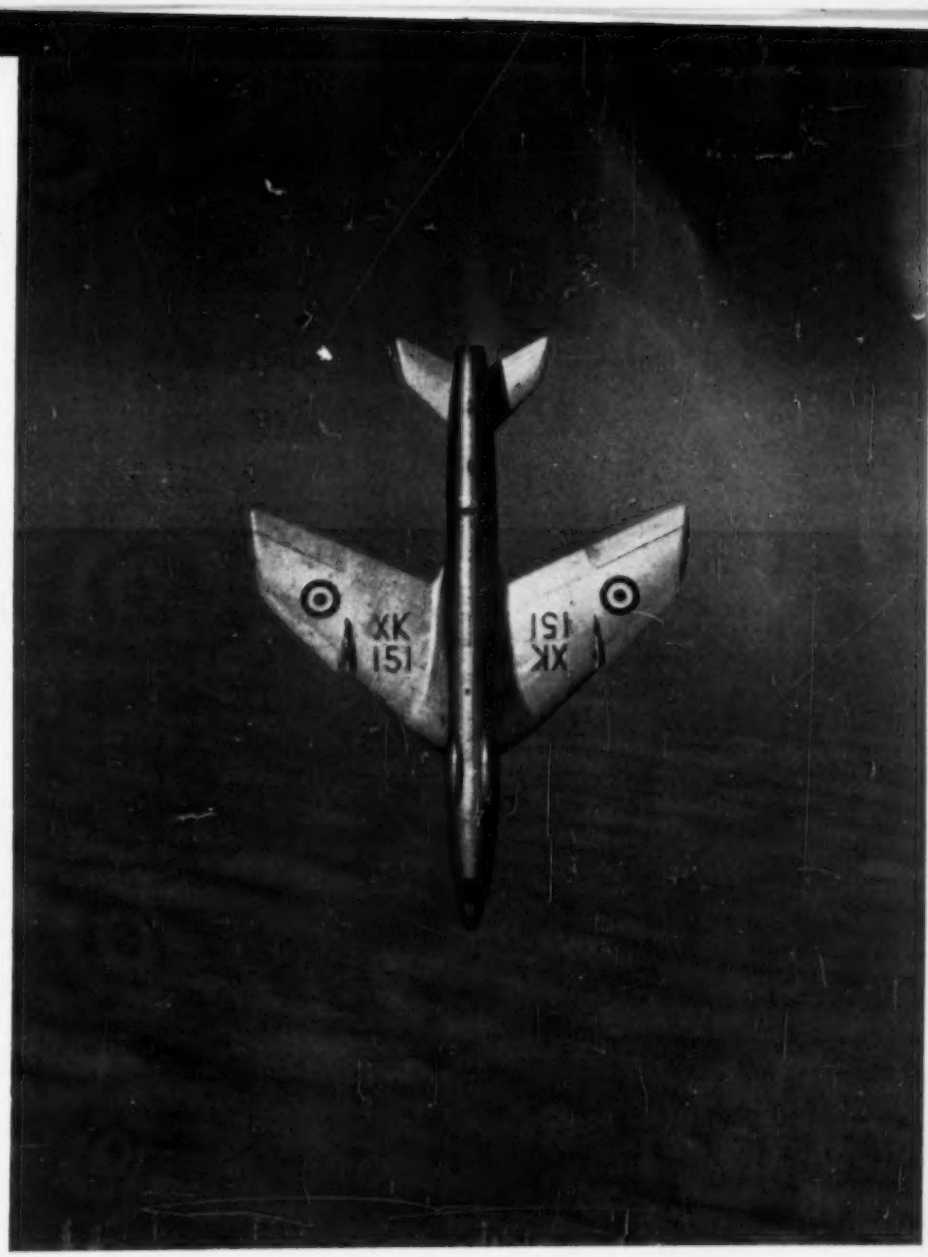
R.A.F. Scholarships

APPLICATIONS for the next competition for R.A.F. scholarships—to be held next February and open to boys not less than 15 years 8 months old on the last day of that month—should be made not later than December 31. The scholarships are awarded by the Air Council to assist boys to remain at school to qualify for later entry into the G.D. (Flying) or Technical branches of the R.A.F. as officer cadets. Full information is contained in A.M. Pamphlet No. 325, obtainable from the Air Ministry (A.R.I.S.), Adastral House, Theobalds Road, London, W.C.1.

Recent Appointments

AMONG appointments recently announced by Air Ministry are the following:—

W/C.s C. H. C. Down to H.Q. No. 19 Group, for technical staff duties; A. D. Adams to R.A.F. Manby, for technical duties; H. R. J. Hailstone to R.A.F. Binbrook, for technical duties; T. R. F. Handcock to No. 21 M.U., Fauld, to command; M. Hermiston to R.A.F. Waddington, for technical duties; H. E. Hunt to the Joint School of Chemical Warfare as Assistant Commandant; E. Plumtree to R.A.F. Jever, for administrative duties; W. H. Webber to H.Q. Bomber Command, for technical staff duties; W. D. Woods to H.Q. No. 18 Group, for technical staff duties.



"Eyes down looking," F/L. K. J. Goodwin—in a Hunter F.6 from the C.F.E., West Raynham—performs one of the brilliant manœuvres which at European air displays during the past two years have proved him to be one of the R.A.F.'s leading aerobatic pilots. Behind the camera's eye was Air Ministry photographer "Mick" Chase in a Meteor 14 flown by F/L. A. G. N. Hampton.

Service News In Brief

The carrier H.M.S. *Bulwark* will be among ships of the Home Fleet taking part with units of the Atlantic Fleet of the Royal Canadian Navy in joint exercises in the Western Atlantic early next year.

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Forty cadets from the R.A.F. College, Cranwell, and the R.A.F. Technical College, Henlow, are spending their Christmas holidays ski-ing. The largest party (28) is at Zermatt, Switzerland, and other parties are visiting Austria and the Cairngorms.

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Four D.H. Otters were recently handed over to the Indian Air Force by de Havilland Aircraft of Canada, Ltd., and are being transported to India by sea. The aircraft, first of an undisclosed number of Canadian-built Otters for the I.A.F., will be maintained and flown by the I.A.F. but used mainly by other Indian Government departments for varied duties.

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Members of the No. 111 Sqn. formation aerobatic team will be on the R.A.F. stand at the Schoolboys' Own Exhibition—being held at the Horticultural Hall, London, S.W.1, from December 31 until January 11—to talk to visitors about Hunter aircraft and aerobatics.

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Ties and ashtrays bearing the No. 206 Sqn. badge are now available at 16s 6d and 5s 6d respectively, both prices including postage. Those interested should write to the Adjutant, No. 206 Sqn., R.A.F. St. Eval, Wadebridge, Cornwall.

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The third R.A.F. anniversary concert is to be held at the Royal Festival Hall, London, on April 18 next year. This concert will have the dual significance of marking the 40th anniversary of the R.A.F. and taking place in the centenary year of the Hallé Orchestra, which will be performing. These concerts are the outcome of the Hallé's wish to pay tribute to the R.A.F.

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A pair of ceremonial steel gates, to be known as St. Andrew's Gate and bearing the civic arms of Uxbridge and the badge of the R.A.F. station, was officially opened at R.A.F. Uxbridge on December 16. The gates were made by trainee tradesmen at No. 8 School of Technical Training, R.A.F. Weeton, Lancs. Approximately 65 trainees—including blacksmith, welder, machinist, pattern maker, moulder, sign-writer and general fitting tradesmen—worked on the main structure, side gates and surrounding brickwork.

ENGINE INTAKE CONTROLS

Increased Performance Through Positioning of Shock-waves

By BRUCE A. C. STACK, A.M.I.Mech.E.*

AIR consumed by a jet engine enters the engine compressor *via* a duct or cowl. At supersonic speeds, the passage of the cowl through the air gives rise to shock (pressure) waves. If the shape of the cowl remains constant, any variation in speed, temperature (altitude), and airflow past the intake breaks up the smooth passage of air to the engine, reducing operating efficiency and increasing drag. New control systems, developed by the Honeywell organization, enable the cowl shape to be varied automatically to control the effects of the shock-waves and thereby improve engine inlet performance by as much as 80 per cent. The new systems are an essential feature of the designs of the Convair B-58 and the Hawker P.1121.

The turbojet engine, when operating under a fixed flow condition of Mach number, temperature, altitude, engine speed and constant corrected fuel flow, requires a fixed volume flow of air. The engine can be considered as a constant-flow machine consuming a given weight of air—proportional to the air pressure at the engine inlet—per unit of time. When the inlet pressure increases by a given percentage, the rate of air (weight) flow increases by the same percentage. Thus the engine inlet cowl must be designed with a pressure recovery that will allow the optimum air weight flow to pass through the engine at any given operation condition. The engine will then produce more thrust, since thrust from a turbojet increases with increase in total pressure at the inlet.

At Mach numbers up to about 1.4 the pressure losses from the normal shock-wave which forms ahead of the engine cowl are small, and so the simple cowl inlet is adequate for subsonic and transonic speeds. As Fig. 1 indicates, the shock losses become increasingly severe at flow speeds greater than Mach 1.4, and it is therefore necessary to find a method of capturing the inlet air efficiently. Experience has shown that this function is most efficiently performed, over a wide range of flow conditions, by a variable-geometry inlet diffuser.

Variable Inlet Diffusers. It should be appreciated that the function of a diffuser is to convert the kinetic energy of the flow into static pressure, with a minimum of shock or functional loss (i.e., with a maximum total pressure). Hence the task of the diffuser is "pressure recovery" and it functions as a flow decelerator.

It is as well to differentiate between subsonic and supersonic diffusers. The configuration of the two types can be determined by means of an equation derived from basic considerations of mass and momentum conservation:

$$\frac{du}{u}(1-M^2) = -\frac{dA}{A}$$

where u is the velocity of flow, M is the local Mach number of the flow u/a. A is the local cross-sectional flow area and a is the local speed of sound.

In subsonic flow, where M is less than 1, the equation shows that the velocity varies inversely with the cross-sectional area. This means that a diverging channel is required to decelerate the flow. Dr. Rudolf Hermann† states that the amount of divergence is determined experimentally as the maximum angle between the diffuser wall and the axis for which the boundary layer remains attached. This half-angle is usually about 3.5 deg. In supersonic flow, where M is greater than 1, the above equation shows that velocity varies directly with the cross-sectional area. Hence a convergent channel provides the proper way to decelerate supersonic flow.

Since the task of the diffuser is, eventually, to decelerate the flow to a low subsonic velocity, the converging channel forming the diffuser for supersonic flow is usually followed by a diverging channel forming the diffuser for subsonic flow. The intersection of these two channels forms the diffuser "throat," where the cross-section is at a minimum. The supersonic airstream entering the inlet must be decelerated to a subsonic velocity of around Mach 0.4 before reaching the compressor. This deceleration is achieved most efficiently by a sequence of shock-waves—one or two obliques and eventually one normal shock. The oblique shocks are usually produced by either a cone or a wedge, according to the type of engine installation.

In wing-mounted engines with circular inlets, a centrebody with a conical nose is used. A conical oblique shock-wave is produced by the tip of the spike centrebody, and the stream-lines are altered by any change in shock cone position. Bleed-off doors in the cowling divert the excess flow of air to position the normal shock for optimum shock pattern and diffuser pressure recovery (Fig. 2).

Inlets for engine mounted in the fuselage may use a ramp or wedge to produce the oblique shock-wave. As the shock-intensity and pressure losses across the shock depend upon wedge angle, maximum pressure recovery is achieved by varying the wedge angle with Mach number. The wedge angle is increased with speed, producing a system in which each of the oblique-shock

*Aeronautical Division, Honeywell-Brown, Ltd., Greenford, Middlesex.

†"*Supersonic Inlet Diffusers and Introduction to Internal Aerodynamics*" (published by Minneapolis-Honeywell Regulator Company, Aeronautical Division, 2600 Ridgway Road, Minneapolis, Minn., U.S.A.

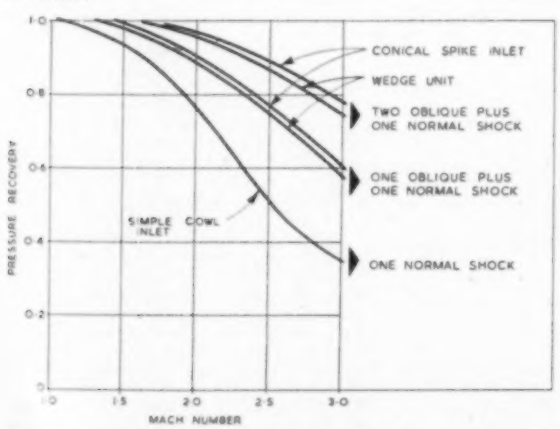


Fig. 1. Pressure recovery, affecting engine performance, is improved by over 80 per cent when inlet shape is varied to position shock waves.

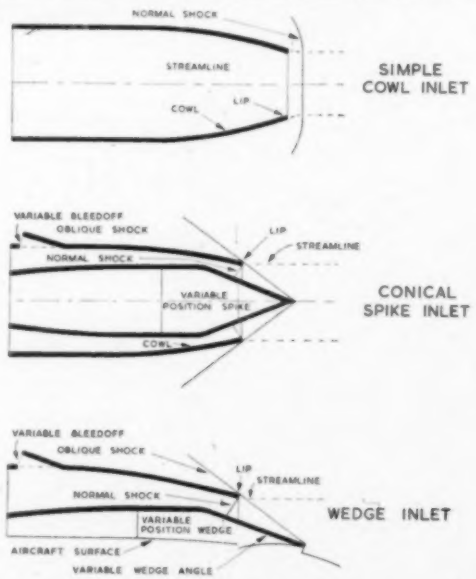
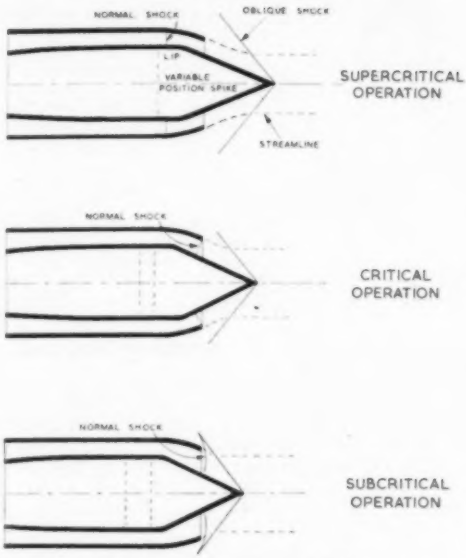


Fig. 2. Automatic controls continuously vary the shape of engine inlets to cut drag and boost engine performance at supersonic speeds.



ENGINE INTAKE CONTROLS . . .

pressure losses approximately equals the remaining normal-shock pressure losses. Maximum diffuser pressure recovery, which is equal to the product of the individual shock-wave recoveries, will occur when each shock wave has the same pressure losses. This balancing of shock-wave losses is not possible in a spike inlet because the actual contour of the spike tip cannot readily be varied.

Downstream of a normal shock wave the flow is always subsonic, because, as the supersonic upstream Mach number increases, the subsonic Mach number folowing the normal shock decreases. The Mach number downstream of the oblique shock-wave is supersonic at nearly all the possible combinations of upstream Mach number and wedge angle. Pressure recovery across a normal shock-wave is nearly unity up to about Mach 1.4; above this figure the recovery drops off rapidly (Fig. 1). Oblique shock-wave pressure recoveries are close to 1.0 for all upstream Mach numbers less than about 2.5.

Critical Conditions. Three general types of diffuser operation exist (Fig. 3), which, though they can be considered independent of the location of the oblique shock wave, are dependent upon the normal shock-wave position relative to the cowl lip:

(a) If a normal shock occurs inside the diffuser, the inlet is said to be operating super-critically. Pressure recovery during super-critical operation is less than at critical because of the strong normal shock wave inside the diffuser. In this case, maximum flow is captured.

(b) If no normal shock occurs inside the diffuser, sub-critical operation exists, with the shock system completely expelled upstream of the cowl lip. The diffuser pressure recovery is less than at critical due to the changes in shock location. Here "buzz" may result and mass spillage occur.

(c) Critical operation occurs when the normal shock wave is near the cowl lip or leading edge of the ramp of the diffuser. This is the most desirable condition because maximum pressure recovery exists, there are no instabilities in the entering airflow, and maximum mass flow is captured.

The oblique shock wave should be positioned to occur at the cowl lip just like the normal shock-wave. The cowl thus takes in the full free-stream airflow, without any stream-line drag at the head of the lip. A variable inlet is required to satisfy these desirable conditions of shock-wave location. Changes in flight speed, and also in temperature and engine airflow, affect the shock location.

At subsonic and transonic speeds the inlet should be varied to give a simple cowl inlet configuration. This may be done by retracting the spike inside the cowl lip, or by reducing the wedge-angle to zero. At supersonic speeds, thrust is a function of aircraft drag. If the engine gets maximum pressure recovery, available thrust will exceed drag; if the engine does not get maximum pressure recovery, it will not give maximum available thrust, and the design speed will not be achieved.

Automatic Controls. It is obvious that, for maximum flight performance, the geometry of an inlet diffuser should be varied continuously and accurately, and this clearly demands an automatic control system. An early appreciation of this fact led the Aeronautical Division of the Minneapolis-Honeywell Regulator Company to make a comprehensive study of the problems involved. This study covered analogue-computer analysis, wind-tunnel tests (made in conjunction with Dr. Rudolf Hermann of the University of Minnesota), and full-scale prototype system tests at the Lewis Flight Propulsion Laboratory of the N.A.C.A. The successful system now in production for the Convair B-58 Hustler supersonic bomber was one result of the study. Another is much in the mind of Sir Sydney Camm in the design of his new strike aircraft.

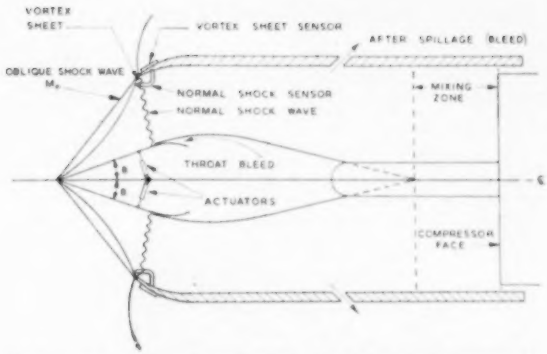


Fig. 4. Actuators alter wedge angle to give best pressure recovery from oblique and normal shock waves. The position of the waves is sensed by pressure probes at suitable locations around the intake.

Fig. 3 (left). The most efficient state—the critical—can be continuously achieved only by continuously varying the shape of the engine inlet. Shock location is affected by temperature (altitude) and engine airflow as well as by flight speed.

In the design of ducting for fuselage-mounted engines many problems arise, but to achieve the maximum benefit it is quite likely that a belly, or ventral, inlet should be used. Here, full advantage can be taken of the wedge-type inlet diffuser, so that, with suitably mounted pressure-sensers and actuators, control is maintained over a wide range of operational conditions.

A typical system (Fig. 4), for normal and oblique shock-wave control, regulates the wedge angle of the ramp as a function of the location of the vortex sheet generated at the intersection of the oblique shock-wave with the normal. The components required for such a system consist of transducers, amplifiers, pressure-sensers and actuators. The pressure-sensers, or probes, are usually designed as a result of tunnel-test programmes, and extensive wind-tunnel work on diffuser probes for present inlet systems has been carried out by the Honeywell organization. Static-pressure probes, or taps, are usually supplied by the airframe manufacturer. Various types of proprietary actuators may be used, depending upon the requirements of each installation. These actuators may be either electro-mechanical or hydraulic.

The pressure sensing probes will sense the total pressure of the vortex sheet (P_{pns}) and the reference pressure (P_r); these are fed as inputs to the transducer which compares the ratio $\frac{P_{pns}-P_r}{P_{pns}}$ with the design preset value of this ratio. Any deviation causes an output signal from the pick-off to be transmitted to an amplifier. The magnitude of this output signal is a function of the error magnitude between the sensed and set pressure ratios, the phase of the signal being determined by the sign of the error. The amplifier receives this signal and supplies power to the actuator, which then drives the wedge in the proper direction to eliminate the error.

For flight Mach numbers below 1.4 the oblique wave becomes detached. This would cause the vortex-sheet control to receive a signal to increase the wedge angle and thus block the inlet. To eliminate this difficulty, a switch is introduced to de-energize the control loop at flight Mach numbers below 1.6.

The normal shock-wave control parallels the vortex-sheet control in operation. Sensed normal-shock pressure (P_{pns}) and reference ramp static pressure (P_{rw}) are fed into a transducer where the ratio $\frac{(P_{pns}-P_r)}{P_{rw}}$ is compared with the preset value of this ratio. Any error from this comparison is amplified to power the actuator and reposition the bleed doors.

The Honeywell Pressure Ratio Transducer in current production is a bellows-type force-balance system contained in a pressure-tight housing, which, with shock-mounting, weighs approximately 4 lb. It is capable of operating at 320 deg F, and of withstanding pressure of 140in Hg supplied at P_p port (total pressure) and 65in Hg applied to the P_r port (reference pressure). Pressure difference must not exceed 75in Hg.

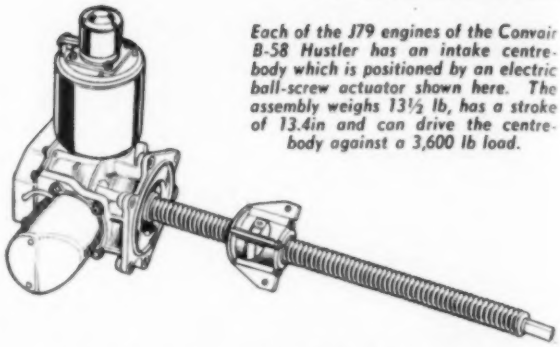
These transducers will hold the set null pressure ratio within ±0.02 pressure ratio increments $\frac{(\triangle P_r)}{P_p}$ over the entire pressure, temperature and vibration values likely to be encountered. The

ENGINE INTAKE CONTROLS . . .

amplifier, with components mounted on a printed card, weighs approximately 3¼ oz. It is a transistor amplifier discriminator consisting of a two-stage voltage and current amplifier, and a stage phase discriminator. The unit requires a single external power source of 115 volts at 400 c/s. A three-terminal output gives phase-sensitive, full-wave direct current. The gain ratio in amperes per volt is adjustable over a minimum gain range from 0.02 to 0.20 amperes per volt. The amplifier also contains provision for an A.C. output if required.

Many parameters are of importance in designing such a system, and extend well beyond those discussed here. Any air breathing engine, turbojet or ramjet, flying at Mach numbers high enough to experience an attached oblique shock at the wedge or cone tip, must have the diffuser profile so designed as to obtain maximum pressure recovery by correct location of the oblique and normal shock waves.

Diffuser throat area and exit nozzle area are critical, as any throttling or back pressure will expel the normal shock wave upstream. There is a "buzz" effect experienced near critical operation of a diffuser, due to the non-stationary flow phenomena. This undesirable effect can cause serious structural deformation, owing to the high-frequency and pressure amplitudes in the engine duct.



Each of the J79 engines of the Convair B-58 Hustler has an intake centre-body which is positioned by an electric ball-screw actuator shown here. The assembly weighs 13½ lb, has a stroke of 13.4in and can drive the centre-body against a 3,600 lb load.

The experimental and analytical investigations of the problems reviewed above challenge the ingenuity of both the research scientist and aeronautical engineer. The results of their work have added considerably to the resources of the aircraft designer.

ON BALANCE (continued from page 980)

announced trading profit for the year ended September 30, 1956, at the new high level of £195,400 against a shade under £180,000. Shareholders were told that the volume of orders on hand were such as to ensure a satisfactory level of production for a considerable period ahead, and that it was believed that the products manufactured by their companies were of a nature least likely to be affected by any cuts in conventional armaments. The Plessey Company's consolidated profit for the year ending June 30, 1957, was returned as £1,486,700 against £1,525,100.

Elliott Brothers (London) issued their 1956 trading profits at the new high record of £788,800 against £405,000 and described their guided weapons and aviation departments as having enjoyed a very active year. It was also stated that they had recently built a special testing station adjacent to their Rochester Works to permit the testing of aircraft flowmeters which they manufactured under licence from the well known American company, Bendix Aviation Corporation.

H. M. Hobson's trading profits for the year ended September 1956 were also a new high level, i.e., £952,200 against £607,500. It was stated that the changing pattern of defence requirements continued to receive the closest attention of the directors.

The Airscrew Company and Jicwood celebrated their twenty-first anniversary as a public company by announcing trading profits at the highest for the past six years, i.e., £156,000 to March 1957. This compared with £106,200 for 1956 and £71,200 for 1955.

Flight Refuelling (Holdings) announced trading profits at a new high level for 1956, i.e., £476,000 odd against £345,500 at the same time as the advice that it proposed to increase its capital. Simultaneous news was that the recession of work on military contracts was envisaged as materially affecting profits for the coming year. Every effort, however, was being made to obtain new contracts from countries overseas and further to diversify the company's products.

The R.F.D. Company's trading profits for 1956 at £156,400 compared with a shade under £177,000 for 1955, the latter being a new record. Increased competition was envisaged, but they anticipated being able to maintain and also improve their lead against all competitors.

Tube Investments' trading profit for the year ended July 31, 1957, was returned at a record figure of £15,650,000, compared with £14,615,000. The latter figure, however, was reached after including some £900,000 of exceptional profits arising from increase in price of raw materials. The results of the companies which last year comprised their Aluminium Division were better than they expected in a period of rising costs and world surplus of aluminium.

British Aluminium's trading profits for 1956 were also a new high record, i.e., £4,485,000 compared with £4,340,000. It was at the same time stated that the Board had been actively studying ways and means of taking an interest in the development of further sources of the supply of alumina.

REMOTE SELECTION

A NEW lightweight remote-controlled selector unit which is currently in use on V.H.F. transmitter units has been developed by the Plessey Co., Ltd., of Ilford, in collaboration with the R.A.E. Known as the type 9008, it has been designed to select any one of twelve predetermined angular positions of a rotating shaft, within one 320-deg turn.

Primary movement of the unit is provided by an electric motor operated from a 48 V D.C. supply which may vary between ±6 V. A relay is used to control the operation of the motor and to reverse its rotation. Selection of the required position is by means of a single-pole twelve-position switch at the remote operating position.

Each angular position can be set individually without affecting the other settings and facilities are provided at the rear of the unit for limiting the arc in which the twelve positions are contained. Accurate settings can be obtained by fine adjustments to the output or tuning shaft with a geared-down control knob.

The unit is capable of driving an external frictional load of 2½ lb in and resets within nine minutes of arc on any single position. The average reset error obtained from all twelve positions is better than six minutes of arc. The output shaft at the rear of the unit extends through the front panel to carry a dial co-operating with a pointer. Another dial indicates which of the twelve positions is in use.

Overall dimensions of the unit, which has been designed for mounting in equipment protected against the free entry of dust, are approximately 4in by 4in panel space, by 4½in depth. Weight is about 2½ lb.

EFFICIENT WORKS LIGHTING

AN interesting lighting installation has recently been brought into use at the de Havilland Propeller Company's new factory at Stevenage, Herts. A high bay arrangement installed by Hollophone, Ltd., it may be the first in the United Kingdom to use the latest development in 1,000W MBF/U lamps.

The fittings are mounted at a height of 28ft 6in and spaced 24ft 6in apart, the working area being lighted measuring 210ft × 150ft.

As the work envisaged for the extension was to be of an exacting nature an efficient light distribution with an overall intensity of 25-28 lumens/sq ft was planned. A reading taken on the working plane prior to installation of machinery gave a reading of 35 lumens/sq ft. A sufficient degree of ceiling brightness is achieved to avoid a tunnel effect.

The Hollophone prismatic high bay fitting No. F.3056 is used. Average output of the lamp, which runs on a mains voltage of 230 V, is about 45,000 lumens and rated life is approximately 5,000 hr.

VOKES RESULTS

AT the annual general meeting of Vokes, Ltd., held on December 17, it was stated that the net profit of the group for the year ended June 30 was £165,302, while that of the parent company was £143,804. These figures compare respectively with £157,175 and £135,402 for 1955-56. The group's products of particular interest to the aviation industry include filters (air, oil, fuel and special-purpose) and silencers.

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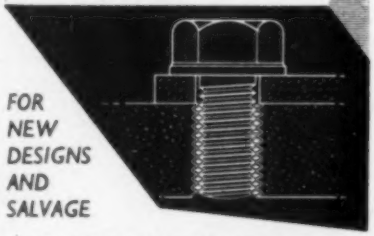

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APPLICATION No. 1570 for a service between London (Blackbushe) and Tarragona (Reus), at a frequency of up to three return flights weekly.

These applications will be considered by the Council under the Terms of Reference issued to them by the Minister of Civil Aviation on 30th July, 1952. Any representations or objections with regard to these applications must be made in writing stating the reason and must reach the Council within 14 days of the date of this advertisement, addressed to the Secretary, Air Transport Advisory Council, 3, Dean's Yard, London, S.W.1, from whom further details of the applications may be obtained. When an objection is made to an application by another air transport company on the grounds that they are applying to operate the route or part of route in question, their application, if not already submitted to the Council, should reach them within the period allowed for the making of representations or objections. [7420

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FURTHER particulars and application form from Secretary, Civil Service Commission, Scientific Branch, 30 Old Burlington Street, London, W.1, quoting S/4795/58. Completed application forms should be returned by 9th January, 1958. [7415

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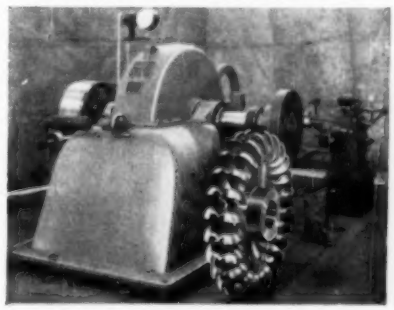

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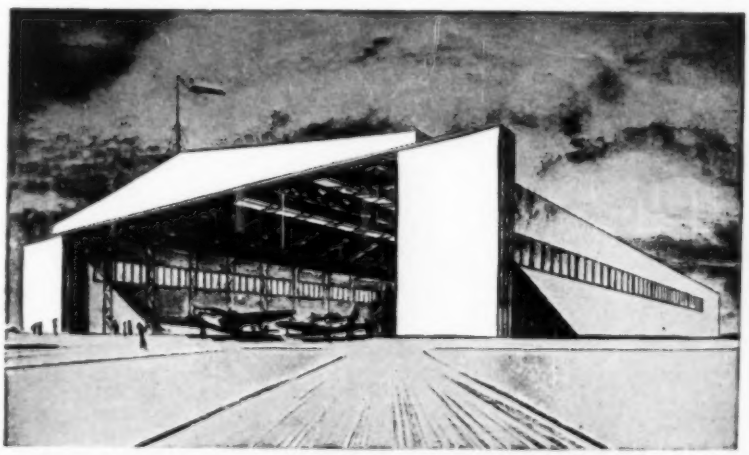

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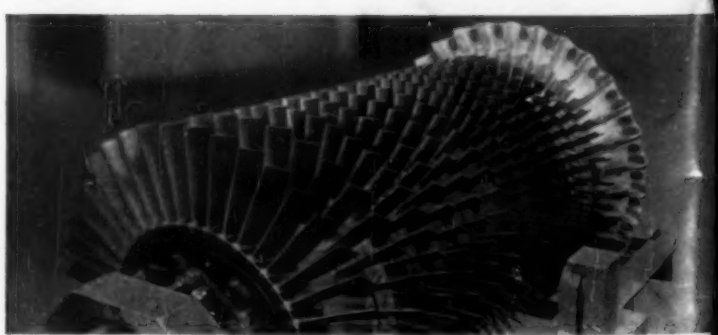

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